CHECKED.

# RETROSPECT

OF

## PHILOSOPHICAL, MECHANICAL, *CHEMICAL, AND AGRICULTURAL* DISCOVERIES:

BEING

An Abridgment

807

OF THE

PERIODICAL AND OTHER PUBLICATIONS,

ENGLISH AND FOREIGN,

RELATIVE TO

*Arts, Chemistry, Manufactures, Agriculture, and Natural Philosophy;*

ACCOMPANIED OCCASIONALLY WITH

REMARKS ON THE MERITS OR DEFECTS OF THE RESPECTIVE PAPERS;

AND, IN SOME CASES, SHEWING TO WHAT OTHER USEFUL PURPOSES INVENTIONS MAY BE DIRECTED, AND DISCOVERIES EXTENDED, BEYOND THE ORIGINAL VIEWS OF THEIR AUTHORS.

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# PREFACE.

On concluding the second volume of this work, the Proprietors are happy in announcing its gradual increase in the public favour, testified by its enlarged circulation; and they trust it will be found that they have fulfilled their pledge to their readers in having strictly adhered to their plan; that they have given accurate and faithful abridgements of all the articles in the several periodical publications devoted to arts, manufactures, agriculture, chemistry, and natural philosophy; and that the observations which have been made on most of the papers tend to distinguish real from imaginary discoveries, useful from trivial inventions, and in many cases show the application of certain discoveries and inventions to objects not in the contemplation of their authors.

With respect to the abridgements, the editors trust they will be found to combine two requisites, which, though always desirable, are not always easily united, namely, conciseness and perspicuity. They exhibit the prominent and distinguishing parts of the respective discoveries and inventions, while they contain nothing extraneous. In the description of different kinds of machinery, it is confidently affirmed that any person of only moderate capacity may obtain a clear idea of the characteristic features of each invention, if he will only exercise a moderate share of that patient attention which he would exert in examining the machine itself. In those few cases where the machinery was too

complicated to admit of a clear description without plates, the reader is at once referred to the original articles.

The observations will, it is hoped, in general shew that the editors have carefully investigated and examined the several topics on which they deliver their opinion: and that they are qualified, as well from their knowledge of the history of arts and sciences, as from their acquaintance with their present state, fairly to appreciate the value of the articles before them; to detect vain and empty pretensions to novelty and ingenuity; to correct the mistakes of ignorance or inadvertence; to hold up to general adoption what is really curious, profound, or valuable; and, in many cases, to extend the utility of inventions and discoveries beyond the original views of those who proposed them. This part of the work may sometimes contain remarks that are obvious to persons thoroughly acquainted with the subjects in hand; but even those persons, we trust, will never be disgusted by the perusal of any thing frivolous or trifling.

The Proprietors flatter themselves, therefore, that they now present to the public, in the compass of one handsome volume of moderate price, an account of all that is really important, curious, and valuable, in the arts, agriculture, and science of Europe, which has appeared since their first volume. And they believe that, while they have omitted nothing material in our own periodical works, they have inserted several articles from foreign publications, which will not be found in any other English work.

London,
February 1, 1807.

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# RETROSPECT

OF

# PHILOSOPHICAL, MECHANICAL,

## CHEMICAL AND AGRICULTURAL

# DISCOVERIES.

No. IV.] *January, February, March.* [1806.

## NATURAL PHILOSOPHY, ARTS, AND MANUFACTURES.

*Observations on the singular Figure of the Planet Saturn. By Dr.* HERSCHEL.—*Phil. Trans.* 1805, Part II.

EVERY person who is at all acquainted with the theory of astronomy, and the principles of universal gravitation, must be aware that the figure of neither this nor any other of the planets can be exactly spherical; but rather that they must be oblate spheroids of different ellipticities. Dr. Herschel had long entertained the same idea with respect to the planet Saturn; but during the months of April, May, and June last, he embraced several opportunities of making observations with his best reflectors, from which he was enabled to ascertain decisively that in this planet the flattening of the polar regions is not so gradual and regular as with Jupiter; it seems not to begin till at a high latitude, and there to be more sudden than it is towards the poles of Jupiter. The dimensions of Saturn, as stated by Dr. Herschel in proportional parts, are as follow:

| | |
|---|---|
| The diameter of the greatest curvature | 36 |
| The equatorial diameter | 35 |
| The polar diameter | 32 |
| Latitude of the longest diameter | 43° 20′ |

This distinguished astronomer concludes his paper with suggesting, that his late observations on the body of Saturn will lead to some intricate researches, by which the quantity of matter in the ring and its solidity may be in some measure ascertained. They also afford a new instance of the effect of gravitation on

the figure of the planets; for in the case of Saturn we shall have to consider the opposite influence of two centripetal and two centrifugal forces: the rotation of both the ring and planet having been ascertained by former observations.

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*Remark.*—A correspondent to the Philosophical Journal (see No. 52) suggests many doubts of the accuracy of Dr. Herschel's conclusions, particularly as other astronomers, whose telescopes defined objects very correctly, and with powers considerably exceeding 160 times, had not noticed this appearance. He therefore recommends farther careful observations about the April opposition, to clear up the point, and to establish a conviction that the singular appearance is not to be attributed to the position of some part of the telescope. To add force to his opinion, this gentleman adduces experiments to shew that a circular or spherical figure, seen by oblique reflection from a concave spherical mirror, will assume the oblong shape ascribed by Dr. Herschel to Saturn.

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*On the Direction and Velocity of the Motion of the Sun and solar System. By Dr.* Herschel.—*Phil. Trans.* 1805, Part II.

This is a subject which has long engaged the attention of astronomers, and respecting which opinions are much afloat: and although Dr. Herschel's observations cannot but be interesting, they still leave the mind of the reader of his memoir in a state of doubt and hesitation. The professed object of Dr. Herschel is to assign both the direction and the velocity of the solar motion; and this object, it is manifest, embraces an extensive field of observation and calculation; he does not, however, in the present paper attempt to ascertain the *velocity* of the solar motion; but proposes to reserve that for a future opportunity. Much of the reasoning in this communication appears to us very hypothetical, gratuitous, and unsatisfactory; we shall therefore not encroach upon pages which we propose devoting to more determined and important particulars, by detailing it. We present the Doctor's concluding remark: "As by observation it is known that proper motions do exist, and since no solar motion can resolve them entirely into parallactic ones, we ought to give the preference to that direction of the motion of the sun, which will take away more real motion than any other; and this will be done when the right ascension of the apex is 245° 52′ 30″, and its north polar distance 40° 22′."

When the promised communication to the Royal Society on the velocity of the solar motion is published, we shall examine it with care, and, if it present any decisive, curious, or momentous results, shall take an early opportunity of laying them before our readers.

*Description of a Property of Caoutchouc, or Indian Rubber; with some Reflections on the Cause of the Elasticity of this Substance. By Mr.* GOUGH.—*Manchester Memoirs, vol.* i. *New Series.*

AMONG the experiments related in this paper, the first demonstrates the reality of a singular fact, namely, that the temperature of a piece of caoutchouc or Indian rubber, may be changed by compelling it to change its dimensions: it shews likewise, that the increase of temperature, which is perceived upon extending a piece of caoutchouc, may be destroyed in an instant, by permitting the stretched slip to contract again.

The next experiment proves, that if a slip of this substance be fastened to a rod of metal or wood, and a weight be fixed to the other extremity in order to keep it in a vertical position, the thong will be found to become shorter with heat and longer with cold. Mr. Gough also shews, that an increase of temperature diminishes the specific gravity of the Indian rubber, and a loss of heat occasions a contrary effect. This latter fact induces him to conclude, that the pores or interstices of caoutchouc are enlarged by heat and contracted by cold; consequently when a slip of this substance, which remains extended by a weight, or the application of force, happens to contract from an accession of temperature, the capacity of its pores, taken separately or collectively, is augmented by the change that takes place in the figure of the thong. Admitting the existence of caloric, Mr. Gough infers that the phenomenon under consideration is occasioned by the alternate absorption and emission of the calorific fluid in the same manner that ropes, the blades of fuci, as well as many more bodies, are obliged to contract and extend themselves by the alternate absorption and emission of water. Thus Mr. Gough's explanation of this case of elasticity depends upon the mutual attraction of caloric and caoutchouc; the former of which penetrates the latter, and pervades every part of it with the greatest ease and expedition; whence the resin is compelled to accommodate its pores to that portion of the calorific fluid which is due to its whole mass at any particular degree of temperature. The reasoning adopted is this: The ease with which this substance changes its figure, and the retractile power which it possesses, shew that its constituent particles move freely amongst themselves: but where there is motion there is void space; consequently caoutchouc abounds with innumerable pores or interstices, the magnitudes of which are variable, because the density of the resin becomes less with heat and greater with cold. Now, if the dimensions of the pores in a piece of caoutchouc can be lessened without taking away part of the matter of heat which it contains at the time,

this new arrangement in the internal structure of the slip will lessen its capacity for the matter of heat, and consequently augment its temperature. But the warmth of such a slip is increased by stretching it; its pores are therefore diminished, and the effort which it exerts at the time arises from the mutual attraction of the caoutchouc and the caloric; whence results an endeavour to enlarge the interstices of the former for the reception of the latter: thus it happens that the thong contracts longitudinally, and the redundant caloric is absorbed in the course of this operation, which again reduces the temperature.

The third experiment furnishes additional confirmation to the preceding theory. If a thong of caoutchouc be stretched in water warmer than itself, it retains its elasticity unimpaired; on the contrary, if the experiment be made in water colder than the caoutchouc, it loses part of its retractile power, being unable to recover its former figure: but let the thong be placed in hot water, while it remains extended for want of spring, and the heat will immediately make it contract briskly. These circumstances are considered as proving that the elasticity of caoutchouc is not a constitutional quality of the substance, but a contingent effect arising from the loss of equilibrium between the portion of caloric which the resin happens to contain at any moment, and its capacity to receive that fluid at the same instant.

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*Observations.*—We are not disposed to make any remarks upon the subject of this article; but we cannot help availing ourselves of the opportunity with which it furnishes us to communicate to our readers some information respecting its author. Mr. Gough, who now resides at Old Hutton, Middleshaw, near Kendal, is justly contemplated by all who have the pleasure of knowing him, or of enjoying his epistolary correspondence, as a gentleman of very extraordinary genius and acquirements obtained under the almost insuperable disadvantage of a privation of sight. His researches have not been confined to any single department of literature, or any isolated branch of science, but he has directed the whole energy of his extraordinary mind to the most important topics of inquiry in nature, art, and learning. The result of his labours has been such as may always be expected to follow in the train of persevering diligence and ingenuity; and we have adverted to it for the sake of presenting a strong stimulus to the young philosopher. As a linguist, as an excellent proficient both in pure and mixed mathematics, as an able chymist and natural philosopher, Mr. Gough is known and admired by all who have perused his various communications to the Manchester Memoirs, the Gentleman's Diary, and the Philosophical Journal. And the following passage from the 17th vol. of the Monthly Magazine will shew how bountifully the loss of one sense has been supplied by the sensibility and perfection of his other faculties: "Cut off in his

earliest infancy from all intercourse with the world of knowledge and observation, through the customary inlet, the organ of sight, Mr. Gough has been induced by the co-operation of this privation with his ardent and insatiable thirst of science, to cultivate with extreme diligence the supplementary faculties of hearing and of touch. The acute perfection to which the latter of these has been improved and expanded, has been sufficiently demonstrated by the extent to which he has carried his practical researches into the minute science of botany; and the exquisiteness of his perceptions in the other kind—the promptitude with which he discovers the stature of the merest stranger by the first resoundings of his voice, and the facility with which he recognises the presence, and discriminates the identity of his acquaintance, by merely listening to their respective breathings, equally illustrate the unprecedented degree of improvement to which he has expanded his hearing faculties."

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*On the Cause of Fairy Rings. By Mr.* John Gough, *and Mr.* J. Florian-Jolly.—*Phil. Jour.* Nos. 50, 51.

The cause of fairy rings, which is not yet agreed upon among naturalists, has recently been considered by the gentlemen abovementioned. Mr. Gough thinks the lively verdure of the grass on the interior edges of these circles may be explained without the agency of lightning or fungi, one or other of which is generally assumed as the cause in the usual hypotheses. The causes he assigns are these:—The dead roots and stems rot and manure the soil which produced them: this source of fertility receives an additional supply from a succession of fungi, which grow and decay on the surface of the ground, as well as from the excrement and exuviæ of the grubs, which take up their abode among the withered roots; lastly, the soil is rendered more porous by the decay of the vegetable remains, and thereby becomes more permeable to the air, which does not a little increase its fertility.

Mr. Florian-Jolly having carefully examined some of these rings in the park at Broadlands, concludes that they were produced by no more uncommon cause than the excrements of horses. He argues in favour of his hypothesis from the appearance in hot-beds; and illustrates his deductions by an experiment with oil let fall upon a marble slab, on which it frequently flows from the centre of the spot it fell upon to the circumference, and accumulates in greater quantities at the boundaries where its expansive motion is stopped.

*On the magnetic Attraction of Oxyds of Iron. By* T. Lane, *Esq.* —*Phil. Trans.* 1805, Part II.

The intention of this communication is to prove generally that mere oxyds of iron are not magnetic; that any inflammable substances mixed with them do not render them magnetic until they are by heat chemically combined with the oxyds, and that when the combustible substance is again separated by heat, the oxyds return to their unmagnetic state.

By repeated experiments Mr. Lane found that heat alone produced no magnetic effect on an oxyd, and that inflammable matter with heat always rendered some of the particles magnetic.

As the inflammable matter in coal had this effect, he mixed some of the oxyd with a portion of coal in a glass mortar, and continued rubbing them together for some time without any magnetic effect. The mixture was then put into a tobacco-pipe, and placed in the clear red heat of a common fire: as soon as the pipe had acquired a red heat, it was taken out: and the mixture being put on a glazed tile to cool, proved highly magnetic.

Mr. Lane rubbed a portion of the original oxyd in a glass mortar with a variety of substances, as sulphur, charcoal, camphor, ether, alcohol, &c. and found that no effect was produced without the assistance of heat. The heat of boiling water was not sufficient; but by the heat of melting lead he procured magnetism. Small quantities of any inflammable matter in a red heat have an evident effect on the oxyd. Hydrogen, aided by a red heat, renders the oxyd magnetic. Alcohol has the same effect: but if the alcohol be diluted with water, though it may flame it will be ineffectual, as it is driven off before the oxyd becomes sufficiently heated to receive its action.

Such combustible substances as do not very readily part with their carbonic element, require rather larger continuance of heat than others; thus charcoal and cinders, well burnt, must be longer in the fire to have their full effect on the oxyd than dry wood, coal, or sulphur. But such substances as may be easily sublimed, will gradually quit the oxyd, by a continued application even of a low heat, leaving it unmagnetic, as at first.

As oxyds of iron, therefore, are rendered magnetic by heat, when mixed with inflammable matter, it may be seen why Prussian blue, sulphurets, and ores of iron containing inflammable matter, become magnetic by the agency of fire, while at the same time it is observable that these same ores revert to their unmagnetic state, when the heat has been continued sufficiently long to drive off the whole of the inflammable matter: thus we find

among the cinders of a common fire calcined sulphurets of iron, distinguishable by their red colour, unmagnetic when all the sulphur is sublimed.

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*Some Facts and Speculations on the luminous Phenomena of Electricity. By Mr.* NICHOLSON.—*Phil. Jour.* No. 50.

THIS ingenious philosopher commences his paper by referring to a communication of his on the same subject to the Royal Society about eighteen years ago: the facts now related were observed nearly at the same period. He first notices three appearances of an artificial ball. It gave flashes; was then luminous, and then gave flashes of another kind.

A ball of $1\frac{1}{2}$ inch diameter being used and electricity communicated by means of a cylinder 9 inches diameter, having its cushion 8 inches long; the excitation was strong enough, by slow turning with a single winch, to throw out large brushes of light. When the rotation was quicker, the flashes disappeared, and the circle of light was seen, having a bright speck moving irregularly round in its periphery. Quicker turning threw out brushes of light very different from the others: these were less luminous in the branches; many started out at once with a hoarse sound: they were greenish at the point or surface of the ball, reddish in the stem, and ramified sooner. Half a dozen were sometimes seen flashing out at once.

In another experiment with a ball of four tenths of an inch in diameter it became luminous, and acted like a point.

A large ball $2\frac{1}{2}$ inches diameter being used, attention was paid to the modifications of the phenomena by the vicinity of a point or small ball. The point being at a great distance, the root of the brush had a luminous circle of lambent light round it on the surface of the ball. When the point was nearer, the brush disappeared, and nothing was seen but an exceedingly bright speck on the surface of the ball, which was sometimes stationary and sometimes moved about. When the point was still nearer the speck it threw out ramified sparks of the second kind, at the same time that a lambent luminous circle appeared. The speck was never in the centre of the circle, but moved at a distance round the circle, irregularly, sometimes one way and sometimes the contrary, and sometimes was stationary.

The ball of four tenths of an inch being held at a certain distance from the two and a half inch ball, when electrified, the first kind of brush was seen on the side farthest from the small ball, at the same time that the second kind of spark or brush flew out towards the small ball, and the lambent luminous appearance was seen on the surface.

These facts lead to some remarks on the nature of the electric spark, in which the conjecture of M. Biot, that the light and heat in this phenomenon may have been produced by mechanical compression of the atmospheric air, is questioned. It is observed, that the combustion of flint and steel requires a very minute portion of metal; that electric temperature is extremely elevated; that all metals lose by electricity, and the spark passes only between combustible bodies; and hence it is inferred that the electric spark may consist of, or be accompanied by, a portion of the body from which it proceeds. It is likewise queried, whether fire-balls may not be electric sparks, and the spark a fire-ball? But, as Mr. Nicholson justly observes, "we are more in want of facts than of conjectures."

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## *Experiments on the Magnetism of slender Iron Wires. By Mr.* John Gough.—*Phil. Jour.* No. 51.

It is stated by Cavallo as a general maxim of magnetism, that "The magnetism acquired by being placed within the influence or the sphere of activity of a magnet in soft iron, lasts only while the iron continues in that situation; and when removed from the vicinity of the magnet, its magnetism vanishes immediately; but with hard iron, and especially with steel, the case is quite different; for the harder the iron or steel is, the more permanent is the magnetism which it acquires from the influence of a magnet."

Mr. Gough's first experiment is consistent with the above maxim. Apply either pole of a strong magnet to one end of a short horizontal bar of clean soft iron, and a particle of iron equally soft to the other end. This particle will remain suspended at the extremity of the bar until the magnet is withdrawn; but the removal of this power will dissolve the connexion subsisting betwixt the two pieces of iron, and the particle will drop off immediately.

The second experiment contradicts the maxim. Instead of the particle of soft iron, substitute a piece of iron wire of No. 32 in the wiredrawer's scale, the weight of which may amount to two or three grains. The removal of the magnet will not break the connexion formed by its presence between the bar of soft iron and the wire; for the latter will remain attached to the end of the former, by the extremity which was first brought into contact with the iron; if the piece of wire be removed from the end of the bar, the magnetic connexion may be revived by replacing it immediately. The same thing will happen if the wire be expeditiously transferred from the first bar to another rod of soft iron; but it loses its magnetism in 2 or 3 seconds when kept at a distance from all ferruginous bodies which are capable of attracting it, and of being attracted by it. These facts prove wire of num-

ber 32 to be a magnet, the virtue of which is conditional, because its permanency depends on the presence of soft iron, and perhaps on no other circumstance.

In other experiments Mr. Gough discovered that wires of low sizes are not conditional magnets: the 11 smallest wires, the extremes of which were 32 and 22, were all conditional magnets. His experiments shew that wire is converted into a conditional magnet by its passage through the 22 wordle, or wiredrawer's instrument; and that the twenty-third operation brings this quality in it to perfection as far as we can judge from experiment. The preceding observations relate only to wire drawn in Kendal; for the same article manufactured in some parts of Yorkshire, has a much greater propensity to become magnetical.

Mr. Gough then offers some conjectures on the cause of conditional magnetism. The temperature of wire is considerably raised during its passage through the wordle; may it not hence be imagined that this increase of temperature, joined to the subsequent contact of cold air, produces such a new arrangement of the moleculæ constituting the wire as enables it to retain a portion of magnetism as long as it remains in contact with a ferruginous body? If this supposition be true, experiment proves the new arrangement to take place in the 22 wordle; when the slenderness of the wire will occasion it to cool suddenly after passing through the instrument.

The drawing instrument, or wordle, is made of steel; and Mr. Gough suggests the probability that this tool, possessing a slight degree of magnetism given to it by friction or otherwise, assists in producing the necessary arrangement, by acting upon heated and slender wires, while their moleculæ are in a violent motion from the pressure of the instrument itself.

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*Experiments on the Torpedo. By Messrs.* Humboldt *and* Gay Lussac.—*Ann. de Chim.* No. 160, *tome* 56.

The phenomena of the torpedo (*Raja-torpedo* of Linneus) have lately been examined by Humboldt and Gay Lussac, who, while in Italy, &c. availed themselves of every opportunity to obtain these fish. At Genoa they perceived some, but were then without instruments: at Civita Vecchia they sought them in vain: but during their stay at Naples they frequently procured some very large and lively ones. Their experiments were chiefly directed towards the discovery of that state of the torpedo, when it was least capable of exerting its power upon the human frame. This power has been generally described as electrical; but the sensation produced by it is stated, by these naturalists, to be materially different from that caused by the discharge of the Leyden phial. Though the strength of the torpedo is far inferior to that

of the gymnotus of South America, yet it is equally capable of causing painful sensations: indeed its shock is more violent than that of electricity. The animal acts under water, and it is only when it loses strength that the fluid impedes its action. In this case M. Gay Lussac observed, that the shock is not perceptible till the fish is raised above the surface.

The gymnotus gives the most violent shocks without any exterior movement of the eyes, the head, or the fins. Not so the torpedo: each time it gave a shock, a convulsive motion of the pectoral fins was observed, which was more or less violent according as the surface in which the contact took place was larger or smaller. The torpedo must be irritated before it will give the shock; and though its powers may not perhaps be kept constantly charged, yet it is capable of giving a long succession of shocks.

The shock is obtained by a mere touch with the finger; but the contact must be immediate, for metals seem to be non-conductors of its powers: thus, the animal may be touched with impunity by means of a key, or any instrument of metal. The most sensible electrometer, however applied, was not in the least affected by the organs of the fish.

As electric fish, when healthy, exercise their powers as forcibly beneath the water as in the open air, the conducting properties of this fluid were examined. Several persons formed a chain of hands between the superior and inferior surfaces of the organs of the torpedo: the shock was not felt until they had wetted their hands. The action was not interrupted when two persons supported the torpedo with their right hands; and instead of holding each other's left hand, they each plunged a metallic rod into water placed upon an isolated body. Other experiments shewed that flame does not conduct the shock.

From the whole these philosophers conclude that, if the torpedo act by poles, that is, by an electric equilibrium which possesses a tendency to replenish itself, it should seem that these poles exist near each other, on the same surface of the organ. The theory of these vital actions highly merits attentive research. Geoffroy has proved that thornbacks, which give no signs of electricity, are furnished with organs analogous to those of the torpedo. The least injury on the brain of the torpedo destroys its electric powers. Doubtless the nerves are chiefly concerned in these phenomena; and the physiologist, who should admit the power of vital actions, might successfully oppose the theory of the naturalist, who would explain all by the contact of the albumino-gelatinous pulp of the nervous laminæ of the organs of the torpedo.

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*Observations.*—The pain excited by touching the torpedo being of a very peculiar kind, it is no wonder that it has excited the attention of inquiring men at all periods. But unfortunately the

accounts left us by naturalists of different ages are far from corresponding with each other. Although the accounts of the ancients are often mingled with the marvellous, yet they would be least inclined to indulge this disposition when their descriptions would often, as in the case of the torpedo, have to stand the test of personal examination. Let us then state briefly the accounts of some celebrated men, both ancients and moderns.

Theophrastus *observed* that the torpedo conveyed the benumbing sensation through sticks and spears into the hands of the fishermen that held them: and Hero of Alexandria mentions it as emitting effluvia through brass and iron.

Plutarch speaks of the torpedo as not only benumbing all that *touch* it, but as striking a numbness through the net into the hands of the fishermen, and as even diminishing the feeling of those who poured water upon it, if it happened to be laid on the ground alive. He adds, that while the torpedo swims round his prey, he emits certain effluvia that first affect the water, and then the fishes in it, so as to disable them from escaping.

Oppian affirms, that the torpedo will benumb the astonished fisherman, even through the whole length of rod and line. And, like Diphilus, he distinguishes the parts where the powers of the fish peculiarly reside; these he calls λαγονες, the flanks, from which he imagined the animal had a faculty of darting certain substances which he called κερκιδες.

M. Reaumur, being on the coast of Poitou in 1714, took that opportunity to make experiments on the torpedo. He often felt the shock severely, and thought it somewhat resembled that painful sensation felt in the arm upon striking the elbow violently against a hard body. He denies, however, that this impression could be communicated through water, a net, or any other soft and yielding substance; nay, through a stick, except it be a very short one.

Mr. John Walsh made some experiments in 1772, partly at the isle of Rhé, and partly at Rochelle, in the presence of the members of the Royal Academy of Sciences at that place. The experiments were greatly diversified, but we can only mention a few here. A living torpedo was laid on a table, upon a wet napkin; round another table stood five persons insulated; and two brass wires, each thirteen feet long, were suspended from the ceiling by silken strings. One of the wires rested by one end upon the wet napkin, the other end was immersed in a basin full of water, placed on a second table, on which stood four other basins full of water. The first person put a finger of one hand into the water in which the wine was immersed, and a finger of the other hand into the second; and so on successively till all the five persons communicated with one another by the water in the basins. In the last basin one end of the second wire was dipped, and with the other end Mr. Walsh touched the back of the torpedo, when

the five persons felt a shock, differing in nothing from that of the Leyden experiment, except in being weaker. Mr. Walsh, who was not in the circuit, was not affected. This experiment was often successfully repeated, even with eight persons. Hence it was concluded that the action of the torpedo is communicated through metals and water. It was inferred likewise, that the upper and under parts of the animal, like the upper and under surfaces of an electrified plate of glass, are in different states; for a person who touches only the upper or the under surface of the electric organs, will not receive the shock of the torpedo. The action manifestly depends upon the will of the animal, which, however, scarcely exhibits any other motion or effort at the time of exerting it, than a winking of its eyes. The same motion accompanies its fruitless attempts to transmit a shock through non-conductors. A torpedo, when insulated, has given to Mr. Walsh fifty shocks in a minute and a half.

Such, according to this gentleman, are the operations of the torpedo in air. When a large fish, very liberal of his shocks, was held in water, with one hand on his breast, and another on his back, he gave the operator shocks of the same kind as before, but about one fourth of the strength of those given in air. At the very instant of raising him out of the water, he constantly gave a very violent shock, and another nearly as violent, when his lower surface first touched the water on dipping him into it. On briskly and alternately plunging him a foot deep into water, and raising him an equal height into air, besides one or two shocks which he gave during the short time he was wholly in the water, and those which he gave at the surface, he constantly gave at least two while he was wholly in air: so that, according to Mr. Walsh's estimate, he gave above one hundred shocks during the minute in which the experiment was performed.

The conclusions drawn from Mr. Walsh's experiments were farther confirmed by some experiments made on the torpedo at Leghorn, by Dr. Ingenhouz, in 1773.

From the preceding sketch it will be seen, that although the experiments of Humboldt and Gay Lussac, and those of Walsh, agree in many points, they are contradictory in several important particulars: yet, we are not thence to infer that the observations of either were incautiously made. It is easy to conceive that a great variety of circumstances may have a material tendency to affect the result; such, for example, as the season of the year, the situation or position of the animal, the manner of its being caught (whether by a hook or a net), the difference of the sex,—and, if a female, the time of bringing forth. These, and numerous other particulars, which will suggest themselves to the minds of an attentive conductor of experiments, must be carefully remarked, with the corresponding modifications of phenomena, before we can expect to possess any very decisive and satisfactory knowledge of the class of powers that can be exerted by the torpedo.

*Concerning the Differences in the magnetic Needle, on board the Investigator, arising from an Alteration in the Direction of the Ship's Head. By* M. Flinders, *Esq. Commander of His Majesty's Ship Investigator.—Phil. Trans.* 1805, Part II.

Whilst surveying along the south coast of New Holland in 1801 and 1802, Captain Flinders observed that the magnetic needle was affected at sea by the position of the ship's head, that is, by the direction in which the vessel was sailing; and some occasional variations he made in the position of guns and other iron on deck, soon convinced him that the variations were not to be ascribed to them. This gentleman gives tables shewing the errors produced in the magnetic compass by the proper magnetism of the ship; from which it is apparent that some of the observed variations from the north are 4° less, and others 4° greater than the truth; likewise that when this error is westward, the ship's head was east, or nearly so; and when it was westward the head was in the opposite direction. When the observations agree nearest with what was taken on shore, or with what may be deemed the true variations, the ship's head was nearly north or south; and a minute inspection of the tables favours the opinion that the excess or diminution of the variation was generally in proportion as the ship's head inclined on either side from the magnetic meridian.

The inferences which Captain Flinders thinks may be drawn from his observations are these:—1. That there was a difference in the direction of the magnetic needle on board the Investigator when the ship's head was pointed to the east and when it was directed westward. 2. That this difference was easterly when the ship's head was pointed to the west, and westerly when it was east. 3. That when the ship's head was north or south the needle took the same direction, or nearly so, that it would on shore; and shewed a variation from the true meridian, which was nearly the medium between what it shewed when east and when west. 4. That the error in variation was nearly proportionate to the number of points which the ship's head was from the north or south.

Captain Flinders proposes, though with diffidence, a theory of the cause of these differences, which is as below:

1st. He supposes the attractive power of the different bodies in a ship, which are capable of affecting the compass, to be collected into a kind of focal point, or centre of action, and that this point is nearly in the centre of the ship where the shot are deposited, for there the greatest quantity of iron is collected together.

2nd. That this point is endued with the same kind of attraction

as the pole of the hemisphere where the ship is; consequently, in New Holland the south end of the needle would be attracted by it and the north end repelled.

3d. That the attractive power of this point is sufficiently strong in a ship of war to interfere with the action of the magnetic poles upon a compass placed upon or in the binnacle.

Reasoning from the latter supposition, Captain Flinders infers that the effects would have a contrary direction in north latitudes. As the subject is curious and very interesting, we trust other skilful navigators will direct their attention to it.

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*Easy and correct Method of verifying the Position of a Transit Instrument. By* J. S. Butt, *Esq.—Phil. Jour.* No. 50.

The usual method of adjusting a transit instrument by a circumpolar star, requires the clock to keep uniform time for at least 24 hours. The present method is independent of the rate of a time-keeper for so long a period, as well as of any previous observations of right ascension, &c.

*Rule.*—Observe the difference of transits of any two circumpolar stars, that are situated nearly in the same azimuth, or vertical circle, the one above and the other below the pole; and whose difference of right ascension is nearly 180°; viz. Observe the transit of $\alpha$ Cassiop. above the pole, and immediately after it the transit of $\varepsilon$ Ursæ majoris below the pole, whose difference of transit is not more than 15 minutes, and for so short a time the clock or watch may be safely depended upon. Then invert the operation, and observe the transit of $\alpha$ Cassiop. below and of $\varepsilon$ Ursæ maj. above the pole. If their difference of transits is the same in both observations, the transit instrument is accurately in the meridian; if not, the error may be corrected by altering the position of the instrument till their difference of transit is the same in both observations.

Should the error be great, it may be corrected nearly by any of the theorems now in use (*vide* Wales on Time-keepers); or half the difference may be substituted for the error, and by repeated approximation the transit instrument may be accurately adjusted.

The advantage of this method is, that the observer relies upon the stars keeping $\frac{99}{100}$ of the time, which would otherwise be kept by the clock or watch; and it is of no consequence whether the observations follow one another on the same day or week, provided the instrument is adjusted to the same point of the horizon, previous to observation; for there is little or no difference in their precession, &c. during an interval of a month. Another advantage is, that the consecutive observations of the two stars follow each other so speedily, that there is not much probability

of being disappointed by a change of weather. Among the suitable stars in this latitude are Draco and Auriga, Cepheus and Ursa, Perseus and Draco.

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*Abstract of Observations on a diurnal Variation of the Barometer between the Tropics. By* J. Horsburgh, *Esq.—Phil. Trans.* 1805, Part II.

During Mr. Horsburgh's last voyage to Bombay he employed two marine barometers, one made by Troughton, the other by Ramsden, and a thermometer by Frazer. These were placed exposed to a free current of air in a cabin, where the basins of the barometers were 13 feet above the level of the sea.

The hours at which the heights of the barometers and thermometers were taken, viz. noon, 4 hours, 10 hours, 12 hours, 14 hours, and 19 hours, were chosen, because at these times the mercury in the barometer had been perceived to be regularly stationary between the tropics, by former observations made in India in 1800 and 1801. It was found that in settled weather in the Indian seas, from 8 A. M. to noon, the mercury in the barometer was generally stationary, and at the point of greatest elevation; after noon it began to fall, and continued falling till 4 P. M. at which time it arrived at the lowest point of depression. From 4 or 5 P. M. the mercury rose again, and continued rising till about 9 or 10 P. M. at which time it had again acquired its greatest point of elevation, and continued stationary nearly till midnight; after which it began to fall, till at 4 A. M. it was again as low as it had been at 4 in the afternoon preceding; but from this time it rose till 7 or 8 o'clock, when it reached the highest point of elevation, and continued stationary till noon. In unsettled blowing weather, especially at Bombay during the rains, these regular ebbings and flowings of the mercury could not be perceived.

Since Mr. Horsburgh's last arrival in India he has observed that the atmosphere appears to produce a different effect on the barometer at *sea* from what it does on *shore*. As this is a phenomenon very little known, we shall present an extract from Mr. Horsburgh's Journal commencing in April 1802.

"From the time of leaving the Land's End, April 19th, the motion of the mercury in barometers was fluctuating and irregular until we were in latitude 26° N. longitude 20° W. on April 29th; the mercury in barometers then became uniform in performing two elevations and two depressions every 24 hours (which for brevity in mentioning hereafter I will call equatropical motions). From latitude 26° N. to latitude 10° N. the difference of the high and low stations of the mercury in the barometers was not so great, as it was from latitude 10° N. across

the equator, and from thence to latitude 25 S. Within these last-mentioned limits the difference of high and low stations of the mercury in the barometers was very considerable, generally from five to nine hundred parts of an inch, both in the daily and nightly motions.

" When we reached the latitude of 28° S. longitude 27° W. June 7th, the mercury in the barometers no longer adhered to the equatropical motions; but then, as in high north latitudes, its rising and falling became irregular and fluctuating during our run from latitude 28° S. longitude 27° W. (mostly between the parallels of 35° and 36° S ), until we were in latitude 27° S. and longitude 51° E. on the 11th of July. The mercury then began to perform the equatropical motions, and continued them uniformly, during our run from the last-mentioned position up the Madagascar archipelago, across the equator, until our arrival at Bombay July 31st, 1802.

" August 6th, 1802, when the barometers were placed on shore in Bombay, the mercury, for the first six days, appeared to have a small tendency towards performing the equatropical motions, but not equally perceptible as when at sea, the difference between the high and low stations of the mercury in the barometers being great to the day we entered the harbour of Bombay. From the 12th of August to the 22d the mercury could not in general be observed to have any inclination to perform the equatropical motions, although at times a very small tendency towards performing them might be perceived.

" On the 23d of August the barometers were taken from the shore to the ship. Immediately on leaving Bombay harbour, August 26th, 1802, the mercury in the barometers performed the equatropical motions, and continued them with great uniformity during our passage down the Malabar coast, across the bay of Bengal, in the strait of Malacca, and through the China sea, until our arrival in Canton river on the 4th of October. When in the river, the mercury became nearly stationary during the 24 hours, except a small inclination at times towards the equatropical motions, but they were not near so perceptible as at sea; this change taking place the day we got into the river.

" During our stay in China, the barometer on shore, at Canton, had very little tendency towards the equatropical motions throughout the months of October and November that we remained there. At times, while in China, a small inclination towards performing the equatropical motions appeared; but, as in Bombay, the difference of rise and fall was of so small a quantity, as to be frequently imperceptible.

" December the 2d, 1802, on our departure from Canton river, the equatropical motions were instantly performed by the mercury, and with great regularity continued during the whole of the passage to Bombay, until our arrival in that harbour on

the 11th of January 1803. On January the 18th, the barometers were placed on shore, and did not appear in the smallest degree subject to the equatropical motions; although, with great regularity, they had been performed while at sea, even to the day we entered the harbour."

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*A Comparison of some Observations on the diurnal Variations of the Barometer, made in Peyrouse's Voyage round the World, with those made at Calcutta by Dr. Balfour.—Hist. Roy. Soc. Edin.* 1805.

M. Lamanon, an ingenious naturalist, who accompanied Peyrouse, was provided with one of Nairne's marine barometers, which, he says, was so little affected by the motion of the ship, that it might be depended upon to the $\frac{1}{100}$ of an inch. In this barometer he tells us, that, from about the 11th degree of north latitude, he began to perceive a certain regular motion, so that the mercury stood highest about the middle of the day, from which time it descended till the evening, and rose again during the night. As they approached the equator, this became more distinctly perceptible; and on the 28th of September, the ship being then in 1° 17′ north latitude, a series of observations was begun, and continued for every hour till the 1st of October at 6 A. M. The following abstract shews the result of the observations on the 28th and 29th of September.

| | | | |
|---|---|---|---|
| 28th. | From 4 to 10 A. M. | Barometer rose | 1 *l.* $\frac{9}{100}$ |
| | From 10 A. M. to 4 P. M. | fell | 1 $\frac{2}{100}$ |
| | From 4 to 10 P. M. | rose | 0 $\frac{9}{100}$ |
| 29th. | From 10 (28th) to 4 A. M. | fell | 1 $\frac{3}{100}$ |
| | From 4 to 10 A. M. | rose | 1 $\frac{5}{100}$ |
| | From 10 A. M. to 4 P. M. | fell | 1 $\frac{3}{100}$ |
| | From 4 to 10 P. M. | rose | 1 |

The observation on the 30th was to the same effect; and hence it is concluded that at the equator the flux and reflux of the atmosphere produces in the barometer a variation of about 1 line $\frac{2}{10}$ English, corresponding, as M. Lamanon remarks, to a height in the atmosphere of nearly 100 feet. According to Bernouilli, the action of the sun and moon should produce a tide of 7 feet, and according to Laplace, a tide not nearly so great.

It should be observed, that when these observations were made, the moon was in her last quarter, and the sun a few degrees to the south of the equator. The latitude on the 28th was 50′ north, and 11′ north on the 29th; in the night between that and the 30th, the ship crossed the line; and on the 30th at noon, the latitude was 42′ south: the longitude all this while between 17° 31′ and 18° 33′ west of Paris, by the timekeeper; so that the coast of Africa, which was the nearest land, was distant

about 8° of a great circle, and the American continent about 19°.

The agreement between these and Dr. Balfour's observations at Calcutta is very remarkable. Dr. Balfour found that during the whole lunation, in which he observed the barometer from half hour to half hour, the mercury constantly fell from 10 at night to 6 in the morning; from 6 to 10 in the morning it rose; from 10 in the morning to 6 at night it fell again; and lastly rose from 6 to 10 at night. The *maximum* height is therefore at 10 at night and 10 in the morning, and the *minimum* at 6 at night and six in the morning. The only difference is, that in M. Lamanon's observations, the *minimum* is stated to have happened at about 4 instead of 6. This, however, will not seem a very material difference, when it is remembered, that the instant when any quantity attains either its greatest or its least state is not easily ascertained with precision. From the observations as detailed by M. Lamanon, the time of the *minimum* seems to answer fully as well to 5 as to 4; so that the difference of the results is in every view inconsiderable, and their coincidence on the whole not a little singular. The variations in Dr. Balfour's barometer between the nearest *maximum* and *minimum* is sometimes about $\frac{1}{10}$ of an inch, though in general considerably less.

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*Observations.*—Instead of proposing any unsatisfactory theory, to account for these variations of the barometer (and we acknowledge our inability to propose any that is not unsatisfactory), we shall throw into this place the results of other observations upon this instrument by various philosophers in different parts of the globe; being sensible that these and much more extensive collections must be arranged and examined, in order to the establishment of any plausible hypothesis.

Several members of a German meteorological society have registered many observations upon the barometer. The most noted of the observers are MM. Steilehner, Planer, Chiminello, and Hemmer. The first of these gentlemen says that he found by several comparative observations, that the greatest fall of the barometer does not happen in very remote places at the same time, but that it is earlier towards the west, and later towards the east, and that the difference of the time is nearly equal to the difference of the meridians of the places; an assertion which deserves to be accurately examined.

M. Planer observed the barometer for a whole year, six times every day, viz. at 2, 6, and 10 o'clock in the morning, and at the same hours after noon; and found in general, that the barometer between 10 in the morning and 2 in the afternoon, and between 10 at night and 2 in the morning, was less in its rising, and greater in its fall; and that the contrary was the case between the hours of 6 and 10 in the evening and morning. M. Chiminello observed the barometer 22 times a day for three

years, but he left a chasm in the night, which he supplied *by calculation*. The principal positions which he thence deduced are, that the barometer falls towards noon, as well as towards midnight.

M. Hemmer deduced the three following general rules from a great number of accurate observations: 1st, When the sun passes the meridian, the barometer, if in the act of falling, continues to fall, and the falling is accelerated. 2d, When the sun passes the meridian, the barometer, if in the act of rising, falls, or becomes stationary, or rises more slowly. 3d, When the sun passes the meridian, the barometer, which is stationary, falls, if it has not risen before or after being stationary; in which case it usually becomes stationary during the sun's passage.

From a register kept by a Mr. Dunbar, near the banks of the Missisipi, in N. lat. 31° 28′, we find, that, for the space of about four days before, and six days after the summer solstice, the barometer regularly rises from about 9 P. M. to about 6 A. M. then falls till the return of the former hour in the evening, then rises again as before, &c. in alternate periods. In the first four days the direction is *ascending*, and the elevation of a line drawn through the mean is about $\frac{6}{100}$ of an inch. In the latter six days the mean line is perfectly horizontal, the elevation each night amounting to $\frac{2}{100}$, and the depression each day to the same, but occupying double time.

The celebrated M. Humboldt made some interesting observations at Caraccas in South America, near the equator. There are, he says, four atmospherical tides every 24 hours, which depend only on the attraction of the sun. The mercury falls from 9 in the morning to 4 in the evening: it rises from 4 to 11 o'clock: it falls from 11 o'clock till past 4 in the morning: and it reascends from that time till 9 o'clock. *Neither winds, storms, nor earthquakes, have any influence on this motion.*

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*Description of a Cometarium, invented by* Ezekiel Walker, *Esq.* —*Phil. Mag.* No. 93.

The first part of this instrument consists of a mahogany board 14 inches in length and 10 in breadth, fixed to a stand in a vertical direction, by a process which need not be particularly described. Near the top of the board a hole 6 inches wide and 3 inches high is cut through it; the top of the hole being 3 inches from that of the board. A double convex lens, 4 inches in diameter, and 24 inches focal distance, is mounted in a square frame 6 inches within. The lens turns round within this frame upon two pins, like a looking-glass that is made to stand upon a table. This frame is made fast to the board which screws around the above-mentioned hole, so that one part of the lens may be on one side of the board, and the other part on the other side. About

$2\frac{1}{4}$ inches below the centre of this lens another lens of half an inch in diameter, and 36 inches focal distance, is placed on the back part of the instrument, against a hole made through the mahogany board. This lens requiring adjustment is set in a small piece of wood that slides in a dove-tail frame fixed to the back part of the instrument; and a lens of $1\frac{1}{2}$ inch diameter, and 40 inches focal distance, is fixed in a hole near the bottom of the board.

Having set the instrument upon a table, with its back turned towards a white wall, at the distance of 23 inches, turn that part of the great lens which is behind the instrument, until it makes an angle of about 50° with the top part of the frame in which it turns. Then place a lighted candle before the cometarium, at the distance of 18 feet, and the light which passes through the great lens will form a beautiful representation of the tail of a comet upon the wall, while the light which passes through the small lens will represent its head, and that light which falls upon the other lens is converged to a circular spot which represents the sun.

When the instrument is turned round by hand on the pin which supports it, the comet revolves round the sun, the head and tail of the comet always keeping in the same position with respect to the sun, in every part of its orbit: and as no light is suffered to pass through the instrument except that which goes through the glasses, and there being no light in the room except one candle, the luminous pictures are exhibited upon the dark shadow made by the opake parts of the instrument, exceedingly clear and well defined; the brilliancy of the comet's tail gradually diminishing towards its farther end.

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*Observations.*—This contrivance is founded upon a property of the convex lens which does not appear to be generally known: it will probably furnish a representation of the figure of a comet more accurate and natural in most respects than has hitherto been obtained. But the name of cometarium is not very appropriaely applied to the instrument, since it neither exhibits the relative magnitudes of the sun and comet, nor nearly the true orbit and motion of the latter. Indeed there is reason to apprehend that the contrivance, so far from serving as a cometarium in its present state, cannot even be adapted successfully to any system of machinery which will correctly exhibit the phenomena of the solar system.

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## *Experiments on Bodies falling freely.* By M. Benzenberg.

M. Benzenberg, professor of physics and astronomy at Dusseldorp, published, some months ago, twenty-eight experiments made with balls well turned and polished, which were made to

fall from a height of 262 French feet; at a medium they produced five lines of deviation towards the east, according to the determination of the plumb line, and the theory gives four lines six tenths. These experiments were made in the coal-mines of Schebusch, and furnish additional proof, if it were necessary, of the rotatory motion of the earth. The last experiments made at Bologna by Mr. Guglielmini, gave nearly the same results.

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*Experiments and Observations upon the Contraction of Water by Heat at low Temperatures. By* T. C. Hope, *M. D.—Edin. Phil. Trans.*

Water at the point of congelation, and for some degrees of temperature above it, seems to afford a very singular and curious exception to the general law that bodies are expanded by heat and contracted by cold. The circumstances of this remarkable anomaly are generally believed to be these: When heat is applied to water ice-cold, or at a temperature not far distant, it causes a diminution in the bulk of the fluid. The water contracts, and continues to contract, with the augmentation of temperature till it reaches the 40th or 41st degree. Between this point and the 42d or 43d it suffers scarcely any perceptible change; but when heated beyond 43° it begins to expand, and increases in volume, with every subsequent rise in temperature. The change happens in a reverse order during the abstraction of caloric. Warm water, as it cools, shrinks as other bodies do till it arrives at 43° or 42°; when it suffers a loss of two degrees without any alteration of density. But when farther cooled, it dilates continually as the temperature falls, till congelation actually commences.

Dr. Hope sketches the history of the discovery of this fact, and briefly explains the experiments of Croune, Hooke, Slare, De Luc, Blagden, Rumford, Dalton, &c. previous to describing those made by himself. He has endeavoured to investigate the subject by experiments, freed from the objections levelled against preceding ones, and to prevent either the changes of the actual volume of the water, or the alterations in the magnitude of the instrument, from having any influence on the result.

In his first experiment ice-cold water exposed to a warm atmosphere was about a degree and a half warmer in its lower than its upper parts, till the former exhibited a temperature of 38°; after which it was warmest at the top. Whence, considering the downward course of the warmer moleculæ of the fluid in the former part of the experiment, and its upward progress in the latter part, it is concluded that the colder or upper fluid was rarer at the temperatures near freezing; and the warmer, then the upper, fluid, was rarer at the higher part of the scale.

In the second experiment, with the same cylindrical glass jar

as in the former (depth $8\frac{1}{2}$ inches, diam. $4\frac{1}{2}$), water at 53° was every where cooled by enveloping the vessel with ice-cold water. It was warmest at the top till the temperature of 42°; after which it was warmest by 4° at the lowermost parts: when the same conclusion is deduced as in the former experiment.

In the third experiment a tall glass jar nearly 18 inches high, and of the same internal diameter as the former, containing water at the temperature of 50°, was cooled round its upper part by ice and salt. The temperature fell most rapidly at bottom, till about 40°, where it continued stationary; after which the surface sunk to freezing, and congealed. This experiment was protracted to the length of 50 hours, and its general import coincided with the preceding ones. As the fluid below 40° of temperature continued at the top of the vessel, it was not more dense than that at 40°: yet the experiment does not shew that it was more rare: it proves no more than that the contraction ceases at 40°; and that water of 32° is not more dense than water of the temperature of 39° or 40°.

The result of these and some other experiments of Dr. Hope, evince the general fact that heat causes ice-cold water to contract to 40°, and afterwards to expand; and that the greatest density lies between $39\frac{1}{2}$° and 40°. They indicate the nature of the change, but not its amount; and it still remains to determine whether the expansions and contractions be the same at equal intervals from 40. The Doctor is inclined to think that the amount of the dilation by cold is inferior to that occasioned by heat.

In a long note to this paper, Dr. Hope assigns various reasons for thinking the opinion of Count Rumford, that fluids cannot conduct heat from particle to particle, to be inaccurate; and he adduces several experiments in support of the side of the question he has taken. But as this is a point which we think has been pretty clearly decided by various other philosophers, the experiments need not be detailed here.

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*Observations.*—This paper does not in our opinion throw any very new and important light upon the subject to which it is devoted. Indeed the Doctor's confession that his attention had not been directed to the inquiry till within three months of the delivering his communication to the Edinburgh Society, proves that he has deviated very widely from the once respected rule of Horace,

*Nonumque prematur in annum;*

and it is not to be expected that such precipitance will ever enrich the sciences with any valuable treasures. The great author of the *Novum Organum* followed a plan which is much more to be recommended to all those who would explore Nature's secrets to good purpose: he not only *kept* his work nine years, but is said to have revised it carefully once every year during that period.

For our own parts we look upon the point of the expansion by cold from 40° downwards to be so completely determined with respect to pure water, that we shall never peruse any fresh experiments relating to it with much eagerness. We would rather wish future philosophers to inquire whether this manner of change in density is peculiar to water; or whether it does not extend to all such fluids as expand by congelation, if not to other liquids.

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*Experiments on the Temperature of Water surrounded by freezing Mixtures. By* J. Gough, *Esq.—Phil. Jour.* No. 52.

This very ingenious philosopher, after perusing Dr. Hope's paper (see the preceding article), was induced to reason in the following manner:—When water is exposed to a freezing mixture, those particles of it which are in contact with the sides of the vessel, are soon reduced to a temperature lower than the point of congelation; in consequence of this, they are probably converted into minute icicles, which impart a quantity of caloric to the surrounding water at the moment of their formation, thereby preventing its temperature from sinking below 32°. These invisible bodies afterwards begin to ascend slowly on account of the diminution in their specific gravity; and while they rise towards the surface of the water, other particles will approach the sides of the vessel in succession, and undergo a similar transformation. This process would evidently increase the volume of water without diminishing its temperature, supposing it to be ice-cold at the commencement of the experiment. This gradual increase of bulk will explain the appearances described by Mr. Dalton, who found that thermometers filled with water continued to rise when exposed to freezing mixtures, until the enclosed water congealed suddenly, and frequently burst his instruments. The reason why agitation accelerated the congelation of water thus circumstanced appears to be this:—When the invisible icicles become very numerous, the least motion carries them in crowds against the sides of the vessel; where the small quantity of water contained amongst them crystallizes immediately, and cements the whole into a film adhering to the inside of the cup. This hypothesis requires water to be, as it really is, a bad conductor of heat: Mr. Gough examined its merits experimentally.

In the first experiment water at 32° was cooled by a surrounding mixture, and became congealed at the sides, by agitation, having never sunk below 32°.

In the second experiment water at 58° was cooled by an intense freezing mixture. In $7\frac{3}{4}$ minutes it was brought to 32°, at which point it remained stationary 5 minutes longer. The glass was

then taken out of the mixture, and the water being agitated lined the upper part of it for about two thirds of its depth from the brim, with a porous covering of ice; but the remaining part of it was free from all incrustation.

Hence it is inferred, that water cannot be cooled and remain fluid at temperatures below 32°, as is generally supposed. Also, that the water thermometer must expand in cooling, in consequence of some other cause.

The second experiment was repeated with striking circumstances in a cup of caoutchouc, whose capacity for caloric greatly exceeds that of glass.

From farther researches, Mr. Gough concludes, that water expands by a loss of temperature between 41° and 32°; or else, that this fluid begins to crystallize at the upper term; in consequence of which the lower term, or 32°, is not, properly speaking, the commencement of congelation, but the point at which the crystals of water begin to concrete into masses by aggregation.

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*On the partial Fusion of Metals by the electric Discharge.—Phil. Mag.* No. 93.

The author of this communication sent one on the same subject to the editor of the Philosophical Magazine about twelve months ago. His present experiments fully establish the point, that a small quantity of accumulated electricity operates in such manner on a plate of silver, or of copper, as to produce evident marks of fusion; though the effect was scarcely visible on plates of iron. These facts are rendered curious by the consideration that it requires a very large battery to melt a small wire. This distinction between the effects of electric discharges upon plates of metal, and upon wires, may open an interesting field for future observers.

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*Observations on Mr. Hawkins's Patent for Improvements on musical Instruments. By the Inventor.—Rep. of Arts,* No. 44.

These observations relate chiefly to the improvements which constitute Mr. Hawkins's grand piano-forte, and the adaptation of the most essential parts of them to the common square piano, which he can sell at about the usual prices. As we have given a deserved commendation of these inventions in our last number, we shall not transcribe any other part of Mr. Hawkins's observations than what relates to the second, fourth, eighth, ninth, and eleventh

articles of the specification. The patentee proposes very soon to lay before the public a new musical instrument, which he calls the *Claviole*, from its being played on with finger keys, and comprehending all instruments of the viol kind from the violin to the double bass. He completed and publicly exhibited a claviole about four years since in America, under the patent which he procured there, at the same time the English patent was taken out by his father. But an instrument on similar principles was announced a few months since in France, by the name of the *Orchestrina*, as a new discovery; whether or no it was taken from Mr. Hawkins's, is perhaps not easy to determine. That which he exhibited was considered, by musicians, as equal in power to fifteen violins, tenors, and basses, and yet was capable of being played soft enough for an accompaniment to the most delicate lady's voice, by the touch of the finger alone.

By rendering the gut-strings of the claviole water-proof, as in article second, the moisture of the atmosphere will have but little effect upon them; but by being stretched with springs (fourth article) they will keep in tune many months, perhaps years. Mr. Hawkins stretched forty-five gut-strings, of various sizes and lengths, and tuned them with a spring to each; they remained in good tune during five months without one breaking, or being likely to break.

The claviole has been among the desiderata of musical mechanists for a long time; the principal thing wanted was an equivalent to the common violin bow, but possessing the faculty of rotation. Horse-hair only was admissible, as being the best known substance to draw tone from a gut-string. A circular motion appeared the best calculated to produce a continued sound. But how to apply horse-hair to a wheel, and still to preserve all the elasticity of the violin-bow, seems not to have been discovered till about ten years ago, when Mr. Hawkins contrived the method described in the ninth article of the specification, and then made a circular bow, which possessed all the smoothness and elasticity of the violin-bow. This he attached to a violin; and by giving it motion, drew the finest tones of which the violin was capable, and which were continued during pleasure; for although the inner surface of the hair is polygonic, and not circular, yet the angles are so very obtuse that the finest ear cannot discover their passage over the strings.

*** We hope Mr. Hawkins will not be long before he is able to exhibit his claviole, for the inspection and trial of the musical amateurs of this country.

*Description of a new fluid Microscope. By* D. Brewster, *A. M.* —*Brewster's Ferguson,* vol. ii.

This microscope is both in shape and nature widely different from the fluid microscope of Mr. Stephen Gray, described in the Phil. Trans. Nos. 221 and 223. Its exterior appearance is much like that of the new pocket microscope invented by Messrs. Jones of Holborn, and described in vol. ii. of Dr. Hutton's Dictionary: there is a vertical bar fixed upon a horizontal pedestal; and from the top of this bar proceeds a horizontal arm, which supports a circular case containing the lenses: below this another horizontal arm slides up and down, capable of adjustment by means of a screw, and carrying the usual sliders to hold the object which it is proposed to examine: and upon the pedestal is fixed the frame of a mirror, which has both an inclined and a horizontal motion, in order to illuminate any object upon the slider. The upper circular case is hollow, and contains four or more plano-convex lenses, which are constituted each of a drop of very pure and viscid turpentine varnish, taken up by the point of a piece of wood, and dropped upon a piece of very thin and well-polished glass. The lenses thus formed may be made of any focal length by taking up a greater or a less quantity of the fluid. The lower surface of the glass having been first smoked with a candle, the black pigment immediately below the lenses is then to be removed, so that no light may pass but through the lenses. The piece of glass is then perforated at its centre, and surrounded by a toothed wheel, which, when the wheel is put in the upper circular case, may be turned by a common endless screw, so that the fluid lenses shall be brought severally under an eye aperture properly disposed, and any object be successively examined with a variety of magnifying powers.

*Observation.*—Although the focal length of these lenses will increase a little after they are formed, they may, notwithstanding, serve very well for single microscopes, if they are preserved carefully from the dust: but as they will not admit of being introduced into compound microscopes, without giving a discoloration to the objects examined, they are not likely to be much adopted.

*Description of a horizontal Windmill of a new Construction, the Principles of which may be applied to Water-wheels. By Mr.* John Jackson.—*Rep. of Arts,* No. 46, *New Series.*

In this mill a stout vertical shaft carries two pairs of horizontal arms crossing each other at right angles, so as to form suitable supports for the axles of four wheels carrying as many vanes, each

placed at an equal distance from the vertical shaft, and at quadrantal distances from one to another. There are 9 toothed wheels arranged in the same horizontal plane, and mutually driving one another. The central wheel drives 4 others, which are called mean wheels; and these again, 4 others called extreme wheels: the mean and extreme wheels are attached to the arms by their axles, and are carried about with them when in motion; the extreme wheels are fixed to their axles, and the vanes are fixed to those axles, and consequently turn with them. These vanes are posited with respect to each other, in such manner that their planes make angles of 45°, 90°, 135°, and 180°, with some variable plane; so that while one vane is completely exposed to the wind, a second and fourth are opposed to it obliquely, and the third turns its end towards it, so as to offer but little resistance. Each of the extreme wheels has twice as many teeth as the central wheel; of consequence, during one revolution of the central wheel, each extreme wheel turns half round, and each vane presents its sides alternately to the wind. The centre wheel consists of a drum or hollow shaft, through which the axle of the wheel passes. A handle is fixed to the lower extremity of the drum-shaft, by which the centre wheel is occasionally moved: this arm serves also as an index, and communicates with a circle, representing the horizon, on which are delineated the points of the compass. When the machine is in motion, the index is set and fastened to that point from which the wind blows, in order to adjust the position of the vanes with respect to the wind. Any motion of the index to the right or left of this point, will alter the position of the vanes, and occasion a diminution of power in the machine; and it is by this index that the machine is stopped, or made to turn in a contrary direction; a peculiarity, when referred to windmills, which exclusively belongs to this contrivance. This will, we trust, be found a sufficient explanation of the general plan.

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*Observations.*—We do not rank among the advocates for the adoption of horizontal windmills of any kind; and if we were, we should not be inclined to commend very warmly the general contrivance just now described. Mr. Smeaton, whose authority will have great weight with all practical engineers, gave a decided preference to vertical windmills, though he rated the effects of horizontal ones much too low when he said they did not exceed one eighth or one tenth of the effects of vertical ones. Mr. Jackson's mill has, besides the disadvantage of being subjected to much friction, the additional one essential to most horizontal mills of exposing too much resisting surface to the wind. The best construction of a horizontal mill, we are acquainted with, is that of Mr. Beatson, described in vol. ii. of the Second Series of the Repertory of Arts: and it is certainly greatly preferable to the pre-

sent mill, though its force at the most favourable estimate is not much more than a fourth of the force of a vertical mill having equal vanes. Although we are by no means disposed to charge Mr. Jackson with plagiarism, yet we cannot help thinking we have seen the description of a mill much like his, either in some of the early Philosophical Transactions, or in M. Gallon's Collection of Machines approved by the French Academy of Sciences; and the publication of a nearly similar invention long ago, without its being ever adopted in practice, is of itself a cogent proof of its inefficacy.

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*A Description of an Air-pump of a new Construction. By Mr.* ELIZUR WRIGHT, *Yale College, Newhaven.—Phil. Jour.* No. 49.

THIS air-pump, the invention of which was suggested by a consideration of that of the Rev. Mr. Prince, is, though very effective, extremely simple in its construction. The barrel, instead of being placed vertically as in the usual construction, lies in a horizontal position immediately underneath the pump-plate, and nearly in contact with it: and there are two ducts, which may be called A and B, leading from the pump-plate into the barrel. Two pistons work in this barrel, one entering at each end of it: of these, one called the rod piston is without a valve, being a solid cylinder accurately fitted to the barrel; its rod is also cylindrical, and moves air-tight in a leathern collar, being worked by a pinion, rack, and winch. The other piston is made solid, like the former, but is shorter, and is acted upon by a spring instead of a winch, whence it is called the spring piston. The ends of these pistons are very carefully fitted to each other; so that when they are brought into contact they will form one uniform cylinder without any intervening vacuity. The duct B is continued around the spring piston by means of a circular channel cut into the inside of the barrel, in order that the air may escape on all sides, and pass freely at the duct when the pistons come into contact. A proper pedestal serves for firmly fixing the pump.

The manner of operation is this: Suppose the receiver placed over the duct A, leaving the duct B open to the external air, and the spring piston in such a situation as to exclude the external air from the barrel, while the bar piston is in contact with it. Then, by moving the rod piston towards the duct A, a vacuum is formed in the barrel: moving it past that duct opens a communication between the receiver and the barrel, and the elasticity of the air under the receiver causes it to rush into the barrel and fill it. After this the rod piston being returned towards the duct B, drives before it the air contained in the barrel, and the air pushes back the spring piston, until it is stopped by a shoulder, properly

placed, at the instant the two ends of the pistons arrive at the middle of the duct B. At this period the contact of the pistons prevents any communication of the barrel with the external air. The rod piston is again drawn back towards the duct A; and the other piston, being urged by its spring, follows in close contact, until it is stopped by another shoulder meeting with the end of the barrel, after having passed the duct B, and having continued to intercept the communication between the barrel and the external air. From this description of the pump and manner of working, it is obvious that, when the pump is intended to exhaust, the receiver must be placed over the duct A, the duct B being left open to the external air; but when it is designed to condense, nothing more is necessary than to shift the situation of the receiver on the plate, the duct B being then covered, and A left open to the external air.

It is recommended to have the duct A made very small, and another barrel having similar pistons and ducts, is added, with its rack placed above the pinion wheel, while the other is below it. The advantage of having two barrels arises from the contrary motions of their pistons; for while one augments the capacity of the receiver by moving forward, the other equally diminishes it by moving backward. Thus such an equilibrium is maintained as prevents any oscillatory motion in the mercury of the gage; since there is now no fluctuation of air in the receiver.

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*Observations.*—The air-pumps of Smeaton, Haas, Prince, Russel, Cuthbertson, Sadler, and Mendlessohn, are too well known to need any description here. Each of them possesses considerable advantages; but in point of simplicity, and the comparative ease and accuracy of execution, we are disposed to think this of Mr. Wright, preferable to any before invented. It is, indeed, remarkable, that so simple and effective a contrivance should not have been struck out by several persons independently of each other: but the circumstance is another proof of the justness of the remark, that the order of nature and the progress of discovery are often diametrically opposite; for, while in the operations of intellect we naturally proceed from the contemplation of simple projects to more complex combinations, it is purely the province of an inventive genius, to strip a complex machine (however ingenious and skilful the adjustment and mutual adaptation of its parts) of every cumbersome and unessential appendage, and present a result freed from the chief sources of retardation and irregularity.

Mr. Wright's contrivance, though much to be commended, is, notwithstanding, liable to some disadvantages; and particularly that of resistance occasioned by the spring piston. Of this the inventor was aware, and remarks, that this additional resistance happens only at the small interval while the spring piston is

passing from its natural situation to the duct B. This need not be more than about four times greater than that which is requisite to overcome the friction of the bar piston, and may easily be provided for by increasing the proportion between the radius of the pinion and that of the winch handle. From the preceding description of Mr. Wright's air-pump, it is manifest that by continuing the operation the air of the receiver will be rarefied *as far as its expansive power will permit:* for in this machine there are no valves to be forced open by the elasticity of the air in the receiver (a task which it is soon unable to accomplish); there is, therefore, nothing to prevent the air from expanding to its utmost degree. In this respect it is upon a par with Mr. Cuthbertson's pump; and as it has the advantage in point of simplicity, it might probably be worked so as to indicate a rarefaction exceeding 3000, the usual limit of Cuthbertson's pump, as measured by the syphon gage.

We may take this opportunity to remark, generally, that when experiments require the utmost rarefying power of *any* air-pump the receiver must not, as is usual, be placed on leather, either oiled, or soaked in water. It was long ago observed by Lord Cavendish, that water, whenever the pressure of the atmosphere upon it is diminished to a certain degree, is immediately converted into vapour: indeed, many bodies emit this elastic fluid when the pressure of the air is much diminished; and a piece of leather, in its ordinary damp state, about an inch square, or a bit of green or dry wood, will supply it for a long time. Instead, then, of using leather, let the pump plate and the edge of the receiver be ground very flat and true, with fine emery, so that no roughness remains. The plate of the pump must then be wiped quite clean and dry, and the receiver rubbed with a warm cloth till it become electrical. The receiver being then set on the plate, smear hog's lard, either alone, or mixed with a little oil which has been cleared of water by boiling, round its outside edge; thus will the pump be made to rarefy its utmost, and what still remains in the receiver will be permanent air. If a little of this composition be thinly smeared on the pump plate, it will prevent all risk of scratching it with the edge of the receiver. Leather of uniform thickness, long dried before a fire, and well soaked in this composition, will answer very well, and is expeditious when it is necessary to shift the receivers frequently.

With respect to gages, it ought to be remarked, that as it is impossible to render the pear-gage as dry as other parts of the apparatus, there will be generally some variation between this and the other gages. When it is only intended to shew the utmost power of the pump, without intending to ascertain the quality of the residuum, then indeed the receiver may be set on wet leather. If, in this state, the air be rarefied as far as possible the syphon and barometer-gage will indicate a less degree of rarefaction than in

other experiments: yet, when the air is let in again, the pear-gage will shew a rarefaction some thousand times greater. If the true quality of permanent air after exhaustion be required, the pear-gage will be nearest the truth: for, when the air is rarefied to a certain degree, the expansible fluid emitted by the moistened leather, fills the receiver, and forces out the permanent air; the two first gages then indicate an exhaustion which relates to the whole elastic matter remaining in the receiver, viz. to the expansible fluid together with the permanent air; whereas the pear-gage points out the degree of exhaustion, with respect to the permanent air alone, which remains in the receiver; for, by the pressure of the air admitted into the receiver, the elastic vapour is reduced to its former bulk, and is imperceptible.

The importance of this subject to philosophical men induces us to hope for indulgence in making another remark. Although the air-pump originated in Germany, all its improvements, except this of Mr. Wright's, were made in Britain. Both the pneumatical and mechanical principles of Boyle's construction were extremely different from Guericke's, and in point of expedition and convenience much superior. The double barrel and gage by Hawksbee were important improvements. Vream's method of working both pistons, without an alternating motion of the winch, was truly ingenious; though it is unaccountably neglected by our instrument-makers. Smeaton's method of making the piston work in rarefied air made a complete change in the whole process. And the improvements of Dr. Daniel Rutherford in 1779 (essentially the same as those of Cuthbertson), displayed a correctness and ingenuity which have been little exceeded, even at the present period.

The writer of the above remarks had scarcely finished them, when it occurred to his recollection that the principle adopted by Mr. Wright had been proposed in this country some years ago, though the mode of construction in conformity with the same general method was certainly less ingenious. The air-pump now alluded to, was described, with a diagram, in No. 2 of THE STUDENT, a periodical work published at Liverpool in 1798. In the air-pump there proposed, a tube or cylinder of brass or tin is to be fixed beneath a rectangular mahogany board; and a solid plunger covered with oiled leather to make it air-tight, has a strong wire and a handle at the end, by which the handle may be pulled up or thrust down at pleasure. The pump-plate of brass or tin is to be fixed at one end of the mahogany frame, and an orifice from the middle of the plate communicates by a cylindrical channel with the barrel, (both horizontal), in which the plunger or piston works. A stop-cock is placed between the channel of communication and the barrel; and is so contrived, that when its handle is placed to coincide with the direction of the barrel, there is a free passage for the air from the receiver to

the barrel; while, when the handle is placed transversely with respect to the barrel, there is a communication from the barrel to the external air by a curved or bent channel, which comes out at the centre of the bottom of the cock. In this construction it is evident, that when the receiver is placed on the plate, the pump may be worked: thus, first place the handle of the stop-cock in the direction of the barrel, draw up the piston, and the air from the receiver will fill the barrel; then turn the handle of the cock transversely, push the piston back, and the barrel will be emptied: again, place the handle in the direction of the barrel, and more air will be admitted from the receiver by drawing up the piston, and this expelled by turning the cock, and thrusting back the piston: thus may the exhaustion and rarefaction be continued at pleasure. A reversed manner of operation would manifestly convert the apparatus into a condenser. The inventor of this contrivance does not seem aware of the disadvantages of using moistened leather, to which we have adverted: and he might have improved his construction, by causing springs, acted upon by the handle of the piston at each end of its stroke, to transmit the requisite motion to the cock.

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*Singular Method of forming Walls and Roofs of rural Buildings in Indostan, communicated by M.* Legoux de Flaix.—*Bib. Phys. Econ.* ii. 394.

The method which the Indians have long used, of forming their buildings, unites solidity, convenience, and wholesomeness, to economy and facility of execution: the buildings are safe from conflagration, and will resist violent inundations. Both walls and roof are of earth; and to form houses in this manner the earth dug from the foundations (of 5 or 7 feet deep) is pounded fine, and mixed with coarse sand or gravel; then it is moistened with water five or six hours before it is wanted, and in the quantity necessary for a single day's work alone. The walls are raised all together, from two to four feet thick; in one, two, or three courses in a day, according to the thickness. When the walls are built to the height for the roof, proper openings are made for the beams and joists: the apertures necessary for the doors and windows are, of course, made while the walls are building. About the twelfth day, when the walls are sufficiently dry, they are enclosed in open work-cases of bambou, at two or three feet distance from the surface of the walls, and the intervals filled with firewood, &c. This pile of combustibles is arranged in several stages of three, four, or five feet thick, separated from each other by layers of earth, or half-dried turf, of from eight to ten inches depth; the upper stages are first set on fire, so that the wall is baked through its whole extent from top

to bottom. The charge of the combustibles for each of the stages is so managed, that the lowest is the greatest, and is diminished for each as it becomes nearer the top of the wall; while the pile burns down, the fire of the lower stages still acts on the upper part of the walls, for which reason the upper stages are of less thickness. The fire bakes the walls to a thickness of from six to ten inches, in like manner as tiles are baked in a kiln. And thus walls are built in a single piece, possessing the greatest solidity; and have the more strength, as there are no joints. Of consequence they will present the greatest possible resistance to the impulse of winds, the attacks of floods, and the impetuous torrents of rain for which that region of the earth is celebrated.

The terrace roofs of these houses are made of clay in three layers. The first layer is common clay mixed with an equal quantity of *ole* (a species of powdered marl), and is four or five inches thick. The second layer is only two or three inches thick, and consists of potter's clay. The third layer is half clay, one fourth brickdust, and one fourth sand; the mixture is worked up in a trough like mortar, and spread equally over the terrace to the thickness of about eight inches.

Houses built thus cost about 6 franks (five shillings) for the cubic fathom, and may be made with many stories. One of them, situated on the banks of the Gemna, notwithstanding it is 430 years old, looks as fresh as though it were new.

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*Account of a Graphometer for measuring the Angles of Crystals. By Mr.* R. Bancks, No. 411, *Strand.—Phil. Journ.* No. 49.

This is an improvement of the well-known graphometer of Carangeau, which consists of a graduated semicircle, and a pair of compasses or legs, having their centre in that of the semicircle, but capable of having their points drawn back, so as to be readily applied to any small crystals. The arc of the semicircle is divided into two quadrants by a hinge, so that one part may be turned back out of the way of any mineral which may require to be brought up towards the centre for admeasurement; and the same arc can afterwards be restored to its place, in order to measure the angle. Mr. Bancks avoids this joint by making the arc in the form of a protractor, with a hollow centre and a stud, both lying at a suitable distance on that diameter which terminates the graduations. The compasses are made much like proportional compasses, and the stud, which joins the two legs, may, when requisite, be put into the central hole of the protractor, while the groove in one of those legs may slide upon the stud on the protractor. Thus the crystal may have its angle measured by the detached compasses, which, when applied to the graduated arc, will exhibit the angle by its graduations.

*Report made to the Athénée des Arts of Paris, by MM. Rondelet, Beauvallet, and Duchesne, on the founding the Statue of Joan of Arc in Bronze, in a Way never before used for large Works, by MM. Rousseau and Genon, under the Direction of M.* Gois, *Statuary.—Mag. Encyclo.* tome i.

This report commences with a historic sketch of different methods of founding statues formerly employed, and a view of the chief disadvantages of the great foundery; and reasons for believing that M. Gois's method would answer for the largest works.

M. Gois's statue of Joan of Arc, exhibited in 1802, being much admired, he was employed to make from it a cast of bronze for the city of Orleans, and in order to save time and expense, was induced to have the cast made in sand. The work was undertaken for him by M. Rousseau, who had before made a fine cast from the group of Graces by Germain Pilon, and who employed the workman that had cast them. They made use of the common sand of the founders, which is argillaceous, and always keeps a little moist. After having well raked it, separated all the stones, and broken all the lumps that could be met with, they filled with it a case of 2,20 metres long, and 1 metre broad at the inside, and 16 centrimetres high; the thickness of the wood of the case was 8 centimetres. The sand was strongly beaten with a rammer, 10 centimetres broad and 60 long, and by this operation acquired sufficient consistence to be raised along with the case without danger of running out. After this the statue was placed upon the first case, which is called the *false mould*, because it was afterwards to be replaced by another: the sand was stirred up a little, to permit the most prominent parts to enter it; another case of the same size was then put over the first, and attached to it by four iron points. The true *concave mould* was then begun by modelling each part of the figure with the same kind of sand: care was taken to mould the parts which have a large and uniform surface in a single piece, while the pieces were multiplied for those portions of the statue which have many sinuosities and deep indentations.

The workman having finished the mouldings of the contours of the figure, filled up the empty spaces between them and the case with sand, which he compressed together with such solidity that it appeared like baked earth. The same care was taken with each successive piece, to the number of seven, which completing the top of the statue, the whole was then reversed in order to replace the lowest case, which, as before mentioned, was only

a false mould; and then each part at the lower extremity was modelled in the same manner as the preceding. The pieces of the mould were then cemented together with paste, and secured by wires passing into the cases. The mould being completed, had only to be dried till the time of the casting. A second mould was made, but with less care, to cast the core; and when finished, a coat of modelling clay was applied to its inside, of the thickness intended to be given to the bronze; and without waiting for its drying, it was closed, and the core cast into it, which was composed, as is usual, of equal parts of plaster of Paris and of brickdust. Eight iron rods were laid so as to project a few inches from the core, in order to place it in the mould; the pieces of the mould were dried as well as the core, and the mould and core were put together ready for casting, and secured by presses.

In casting by the great foundery, after the model is finished and oiled, a mould is formed from the statue in separate pieces: a composition of wax is applied to the inside of the mould, of the thickness intended for the bronze. The core is cast in this mould, and the modelling of the wax finished by the statuary after it is taken out. After this the true mould is formed of materials capable of supporting the heat and the impulse of the metals; to compose which three sixths of earth are mixed with one sixth of horse-dung, and left to rot in a ditch for one winter; when this mixture is taken out, two sixths of broken crucibles, well pounded and passed through a sieve, are added: the whole is tempered with urine, and beat up with a stone, being then what is called *potee*.

When it is to be used, water enough is added to a sufficient quantity of it, to make it capable of being laid on with a brush; forty coats of it are then laid over the wax successively (one coat being dry before another is laid on), which all together form a thickness of 5 centimetres (2 inches). The mould is then surrounded with flat bands of iron, which cross each other like network; then, after rendering the *potee* thicker, by adding to it earth and hair that has been well beaten, it is laid on over the former work with the fingers, until the mould has attained the thickness of 20 centimetres (8 inches) below, and 16 (6 inches) above; after which it is surrounded a second time with bands of flat iron.

After this a wall is built round it, the necessary passages for the fire constructed, and the intervening spaces filled up with broken bricks: the fire is then kindled in the passages most distant from the figure, and is gradually increased for nine days, and again diminished for the same space of time. On the second day the wax begins to flow, and continues so to do for 10 or 12 days, when about half of it is lost.

The fire being extinguished, the work is left some days to

cool; then the broken bricks are removed, and before the mould is buried, a coat of plaster about half an inch thick is put over it, which is called the *chemise*. Then they proceed to enclose the mould with earth, first taking care to stop all the avenues through which the wax flowed, and to raise the pipes for the vents, and for the entrance of the fused metal. The earth used for enclosing the mould should be first skreened, and then laid on uniformly in the excavation. After each course is raised to a thickness of 30 centimetres (1 foot), it is beaten down till it is reduced to ten. After this there only remains to build the basin for the reception of the metal, called the *echino*.

As to the statue of Joan of Arc, it was all formed in one mould, except the skirts, one arm, and the plumes of the helmet, which were placed in a separate case. Every thing being prepared for the casting, about 1000 kilogrammes (32 cwt.) of the metal was fused, and the cast made by M. Rousseau; it succeeded completely, for, on removing the sand, no accident had happened, and the statue required neither additions nor repairs. The reporters conclude with high encomiums on the advantages of this method of casting, and recommending medals to be given to MM. Rousseau and Genon by the *Athénee des Arts*, in testimony of their merit; and, that as the rules of the society prevented this recompense from being granted to one of its members, honourable mention should be made of M. Gois.

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*Description of a secret Lock of nearly seven thousand Combinations. By Mr.* W. Nicholson.—*Phil. Journ.* No. 51.

This ingenious journalist has given a concise disquisition upon locks, and especially upon secret locks, their structure, and imperfections: he enumerates the conditions of a perfect lock as follows:

1. That certain parts of the lock should be variable in position through a great number of combinations, one only of which shall allow the lock to be opened or shut.

2. That this last-mentioned combination should be variable at the pleasure of the possessor.

3. That it shall not be possible, after the lock is closed and the combination disturbed, for any one, not even the maker of the lock, to discover by any examination what may be the proper situations of the parts required to open the lock.

4. That trials of this nature shall not be capable of injuring the work.

5. That it shall require no key.

6. And be as easily opened in the dark as in the light.

7. That the opening and shutting should be performed by a process as simple as that of a common lock.

8. That it shall either open without a key, or with one, at pleasure.

9. That the key-hole be concealed, defended, or inaccessible.

10. That the key may be used by a stranger, without his knowing or being able to discover the adopted combination.

11. That the key be capable of adjustment to all the variations of the lock, and yet be simple.

12. That the lock should not be liable to be taken off and examined, whether the receptacle be open or shut, except by one who knows the adopted combination.

Mr. Nicholson has devised a lock which possesses the first six requisites, and is susceptible of 6561 combinations: but as the description is rather too complex to be clearly understood without diagrams, we must refer the reader, who wishes more attentively to consider this piece of mechanism, to the number of the Philosophical Journal specified at the head of the present article.

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*Description of a statical Lamp, which maintains a Supply of Oil to the Burner, from a Receiver placed so low as to occasion no Interception of Light. By* A. F.—*Phil. Journ.* No. 49.

This is an overflowing lamp, the upper part of which contains the usual apparatus of a lamp, either according to Argand's or any other construction. Within the vase or urn that is to support and communicate with this apparatus, is a globular cavity, from the bottom of which is a cylindrical passage reaching nearly to the bottom of the vase: a hemispherical solid, whose diameter nearly equals the interior diameter of the spherical vessel, turns upon a horizontal axis passing through the middle of the vessel, and can rest in part with its flat base upon the surface of any fluid that vessel may contain, the air being never excluded from it. Let us now suppose the specific gravity of this revolving solid to be 6, and that as much fluid brine at the specific gravity of 12 is poured into the vase as would about half fill the interior vessel, and that oil of the specific gravity of 9 is poured upon the brine; it is manifest, that as the quantity of oil poured into the vase increases, it will press upward the brine through the cylindrical passage into the sphere; and that when this sphere is half filled, the oil will stand at an elevation above its axis equal to one half more than the height of the dense fluid measured from its surface where the oil presses upon it. And, when this adjustment is once made, by putting in the proper quantity of dense fluid, if any of the oil be taken out or consumed by burning, the pressure will be less, and the dense fluid will rise within the vase. But this rise will not be attended with any material depression in the interior vessel, because the level will be kept up by the revolving piece, and consequently the oil itself will be prevented

from falling as much as it would have done if this contrivance had not been applied.

The inventor does not disguise the consideration, that as the oil diminishes, the distances between the upper and lower surfaces of the dense fluid must diminish, and a proportional difference or subsidence in the surface of the oil must take place. The remedy he suggests is to make the lower surface as large as convenience will allow, that its rise and fall may be less.

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## *Description of Mr.* G. Smart's *improved Lathe.—Repertory of Arts, &c.* No. 45; *New Series.*

Mr. Smart, of Ordnance Wharf, Westminster Bridge, has occasion to manufacture great numbers of picket and tent poles, and has contrived a lathe by means of which, after they are sawn into an octagonal figure, they are with great dispatch turned into smooth and straight cylinders, all exactly of equal diameter.

In this apparatus, besides the usual puppets of a common lathe, there is an additional one fixed by a wedge under the bed, to receive a square sliding bar, which is advanced and withdrawn by a screw turned by a winch. Between the two middle puppets two slide-bars of oak are firmly fixed, and are farther steadied by three other puppets fixed by wedges; these slide-bars or cheeks are for the tools to slide upon. The mandrill is driven with a velocity producing 1300 revolutions per minute, by a wheel turned by two men: the inner end of the mandrill projects some inches beyond its collar in the second puppet, and has three points in the end; one in the centre nearly as long again as the other two, near the circumference, to prevent the pole from slipping. The band which embraces the mandrill has a pulley pressing against one part of it, to prevent a speedy wearing out in consequence of two parts of the band crossing one another.

There are two cutter-blocks to slide along the cheeks, and in the middle of each is a hole for the revolving pole to pass through. One of these blocks has at one side of the hole, and projecting a little way into it, a gouge, fixed to the block by two screws at the end, and supported by a piece of wood. The other tool, which is the follower, and is to turn the pole smooth, has a hole through it, surrounded by an iron plate, to strengthen it where the wood is cut away to form an opening for a common plane iron, fixed by two screws on the sloping part of the block, in such a position that the iron is nearly a tangent to the circle it is intended to cut, but stands inclined in an angle to the axis of the cylinder; so that one corner cuts before the other; to assist this, the edge of the iron is whetted a little convex.

The wheel and lathe being put into motion, the roughing tool is pushed along in its block upon the slide-bars, gouging the pole

as it goes, in the manner of a screw or spiral. When it reaches the third puppet, the smoothing-tool is pushed forward also, and this leaves that part of the pole over which it has passed perfectly smooth and cylindrical. The lathe is then stopped, and by an easy operation the finished pole is removed, and another octagonal one put in its place to be planed as before.

Mr. Smart has likewise an ingenious contrivance, by which a conical end can very rapidly be turned to any of the poles.

By this machine a pole of yellow deal, five feet and a half long, and two inches diameter, can be turned from an octagonal prism to a perfect cylinder in half a minute; and an ash-pole of the same size in one minute. Two men to turn the wheel, and one to work the tools, will turn 600 deal poles, of the dimensions just specified, in twelve hours.

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*Improved Beam Compasses. By Mr.* Walton.—*Gregory's Mechanics,* vol. ii.

Mr. Walton's improvement consists in applying a nonius, worked by a micrometer screw, to the moveable cursor upon the beam; by means of which obvious additional apparatus, distances can be accurately measured with his beam compasses, to every 100th part of an inch, or the radii of the proposed arcs adjusted to equally minute variations: while in beam-compasses, of the common construction, distances can only be ascertained to tenths of inches. The minutiæ of the construction need not be entered upon in this place.

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*Description of a Tide-mill erected on the right Bank of the Thames at East-Greenwich, under the Direction of Mr.* John Lloyd, *Engineer.—Gregory's Mechanics,* vol. ii.

This mill is intended to grind corn, and works 8 pairs of stones. The side of the mill-house parallel to the course of the river measures 40 feet within; and as the whole of this may be opened to the river by sluice-gates, which are carried down to the low-water mark in the river, there is a 40 feet water-way to the mill: through this water-way the water passes during the rising tide into a large reservoir, which occupies about 4 acres of land: and beyond this reservoir is a smaller one, in which water is kept, for the purpose of being let out occasionally at low water to cleanse the whole works from mud and sediment, which would otherwise in time clog the machinery. The water-wheel has its axle in a position parallel to the side of the river, that is, parallel to the sluice-gates which admit water from the river; the length of this wheel is 26 feet, its diameter 11 feet, and its number of float-

boards 32. These boards do not each run on in one plane from one end of the wheel to the other; but the whole length of the wheel is divided into four equal portions, and the parts of the float-boards belonging to each of these portions fall gradually one lower than another, each by one fourth of the distance from one board to another, measuring on the circumference of the wheel. This contrivance is intended to equalize the action of the water upon the wheel, and prevent its moving by jolts. The wheel, with its incumbent apparatus, weighs about 20 tons; the whole of which is raised by the impulse of the flowing tide when admitted through the sluice-gates: it is placed in the middle of the water-way, leaving a passage on each side of about 6 feet for the water to pass into the reservoir, besides that which in its motion turns the wheel round. Soon after the tide has risen to the highest (which at this mill is often 20 feet above the low-water mark), the water is permitted to run back again from the reservoir into the river; and by this means it gives a rotatory motion to the water-wheel in a contrary direction to that with which it moved when impelled by the rising tide: the contrivance by which the wheel is raised and depressed, and that by which the whole interior motions of the mill are preserved in the same direction, although that in which the water-wheel moves is changed, are truly ingenious. A vertical shaft carries two equal wallower-wheels, which are so situated on the shaft, that one or other of them may, as occasion requires, be brought to be driven by the first cog-wheel which is upon the same axis as the water-wheel; and thus the first wheel acting upon the wallower-wheels at points diametrically opposite, will (according to what has been remarked at pp. 41, 42, of our first volume), although its own motion is reversed, communicate the rotatory motion to the vertical shaft always in the same direction. The apparatus by which the respective wallower-wheels are thrown in and out of geer, though very judicious, cannot be distinctly explained without a diagram.

When the tide is flowing after the mill has stopped a sufficient time to gain a moderate head of water, the fluid is suffered to enter and fall upon the wheel by a sluice, and the tail-water to run out by a lower sluice on the other side of the wheel. The hydrostatic pressure of the head of water acting against the bottom of the wheel-frame, and at the same time acting between two folding gates (forming together a hollow wedge of variable magnitude), thus converts them into very large hydrostatic bellows, buoys up the wheel and frame (though weighing, as before observed, nearly 20 tons), and makes them gradually to rise higher and higher, so that the wheel is never, as the workmen express it, *drowned* in the flowing water; nor can the water escape under the wheel-frame, being prevented by the folding-gates, which pass from one end to the other of the wheel. In this way the

wheel and frame are buoyed up by a head of 4 feet; and the mill works with a head of 5 or $5\frac{1}{2}$ feet.

When the tide is ebbing, and the water from the reservoir running back again into the river, it might be expected, that in consequence of the gradual subsiding of the water, the water-wheel should as gradually lower: but lest any of the water confined between the wheel-frame and the folding-gates should prevent this, there are strong rackworks of cast-iron, by which the wheel can be either suspended at any altitude, or gradually let down, so as to give the water returning from the reservoir an advantageous head upon the wheel: the sluices now open and shut are posited in opposite situations to those for similar purposes when the water runs the contrary way. The upper surface of the wheel-frame is quadrangular; and at each angle is a strong cast-iron bar, which slides up and down in a proper groove, that admits of the vertical motion, but prevents all such lateral deviation as might be occasioned by the impulsion of the stream.

At each end of the water-wheel there is a vertical shaft with wallowers and a first cog-wheel; and each of these vertical shafts turns a large horizontal wheel at a suitable distance above the wallowers, while each horizontal wheel drives 4 equal pinions placed at equal or quadrantal distances on its periphery, each pinion having a vertical spindle, on the upper part of which the upper mill-stone of its respective pair is fixed: other wheels driven by one or other of these pinions, giving motion to the bolting and dressing machines, and different subordinate parts of the mill.

Although the vertical shaft at each end of the water-wheel rises and falls with that wheel, yet the large horizontal wheel turning with such shaft does not likewise rise and fall, but remains always in the same horizontal plane, and in contact with the four pinions it drives: the contrivance for this purpose is very simple, but very efficacious; each great horizontal wheel has a nave which runs upon friction rollers, has a square aperture passing through it vertically, just large enough to allow the upright shaft to slide freely up and down in it, but not to turn round without communicating its rotatory motion to the wheel: thus the weight of the wheel causes it to press upon the friction-rollers, and retain the same horizontal plane; and the action of the angles of the vertical shaft upon the corresponding parts of the square orifice causes it to partake of the rotatory motion, such motion being always in one direction in consequence of the contrivance by which one or other of the wallowers is brought into contact with the opposite points of the first cog-wheel.

Several of the subordinate parts of this mill are admirably constructed, but not in a manner peculiar to tide-mills; they need not, therefore, be described here.

*Observations.*—The erection of a tide-mill within 6 miles of the metropolis, possessing sufficient power to work 8 pairs of stones for nearly 20 hours in every 24, is a subject of too much importance to be passed over silently. Considering the many advantages likely to result from the erection of tide-mills on the banks of such rivers as the Thames, the Humber, the Severn, &c. we have thought it right to insert the preceding account, as it may convey useful suggestions to our mechanical readers. The limits to which the several articles in this work are necessarily confined, will not allow of our minutely explaining the different modes of constructing and placing water-wheels for tide-mills; yet, as the subject, besides being interesting, is, to a great extent, novel, we beg to refer to *Mr. Gregory's Mechanics*, lately published, not merely as the only English work, in which tide-mills are copiously described, but as the only one, we believe, in which they are described at all.

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*Description of a new Parallel Ruler, exempt from lateral Deviation; invented by Mr.* J. W. Boswell.—*Phil. Jour.* No. 52.

In this communication Mr. Boswell states in some prefatory observations, the inconveniences arising from the lateral deviation of the common parallel ruler, and the causes of inaccuracy or want of convenience in the various parallel rulers hitherto contrived to operate without such deviation. A small addition or modification of an instrument, however, sometimes renders its effects essentially different; and of this Mr. Boswell's present contrivance is an instance.

This instrument for drawing parallel lines without side deviation, is formed of three rules laid parallel to each other, connected by two pair of moveable pieces, all of equal length, and parallel to each other; these pieces, where they meet on the middle ruler, have their extremities formed into portions of toothed wheels, which lock into each other: the effect of these segments of wheels thus acting in each other, is, that all the lateral motion is transferred to the middle ruler, while the external ones move only in an opposite direction, retaining their fiducial edges always parallel to each other.

This instrument will not be liable to the incorrectness of the others Mr. Boswell describes for the following reasons: 1st, The toothed segments being no way concerned in producing the parallelism of the instrument, its accuracy in that respect cannot be at all affected by any trifling incorrectness of formation in their parts. 2d, All the connecting pieces being of equal length, can be formed accurately with more certainty. 3d, The passing of the connecting pieces from the same extremities of the external rulers gives them a steady support.

To prevent friction on the paper by the lateral motion of the middle ruler, it should be made a little thinner than the others.

The novelty of this instrument, it will be seen, consists merely in the application of the segments of the toothed wheels at the contiguous ends of the connecting pieces. In consequence of this small addition, however, Mr. Boswell's parallel ruler effectually prevents the side deviation which is produced in the external part of the common triple ruler.

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*The Syphon applied to the Worm-tub as a Refrigerator. By Mr.* Alex. Johnston.—*Phil. Mag.* No. 93.

Mr. Johnston's is a plan for conveying water in any quantity to a worm-tub of the largest dimensions, if perfectly air-tight. The feed-pipe enters the bottom of the tub vertically, while the hot water or waste-pipe branches out from a side orifice near the top, and is soon turned to proceed vertically downwards, until its lower end is about 2 feet below the bottom of the feed-pipe; both the pipes have cocks near their lower ends.

When work is commenced the cocks must be shut, and the tub filled through a hole at top; when full, the hole at top must be stopped, and the cocks both opened together: the water will then commence running, and continue as long as the supply holds good; the apparatus acting entirely upon the principle of the syphon.

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*Account of the Art and Instruments used for boring and blasting Rocks. By* G. C. *of Bristol.—Phil. Jour.* No. 52.

This correspondent gives a description of the tools and of the art, as now practised at the village of Shipham, in Somersetshire; where the inhabitants mine after lead ore, calamine, and ochre, chiefly in a limestone rock.

The tools used are,—1st, A round bar of iron, levelled off at one end; length 18 inches, diameter $\frac{1}{2}$ an inch. 2d, A similar bar of 24 inches long, to follow when the hole in the stone is about 12 inches deep. 3d, A rod, with a loop for the finger, 25 inches long; at the bottom of which is a round flat piece of iron, to draw out the pounded stone occasionally. 4th, A pricker, 24 inches long (with a loop also), used to preserve a passage to insert the priming straw while the hole is rammed or stemmed with—5th, An iron rammer 20 inches long, and which about 6 inches from the end is formed into a conical groove, very open at bottom, in order to enable the miner to ram round the pricker, as well as that by its sharpness at the end, it may the easier break to dust the pieces of spar dropped in as fast as wanted. 6thly, A hammer

with a handle and strap about 5 inches long; the iron head weighing from 4 to 7lbs. according to the strength of the operator.

The work is performed wet, by pouring water occasionally into the hole. At every stroke of the hammer the miner turns his chisel, by which means he works the bottom of the mine in a regular circle, and is enabled to keep his perforation true. When arrived at the depth of 18 or 19 inches, he cleans, and, as well as he can, dries his mine; then inserts his charge of gunpowder, amounting often to an ounce, which is more than is necessary. The pricker is put down in the hole close to the side, and small pieces of spar are dropped in, which are first slightly rammed, and afterwards more firmly. The hole being full, the pricker is drawn, and a wheat straw filled with gunpowder is put down instead of it. This straw must be at least 19 inches long for a hole of 18, and shaved away at the bottom, but of course not cut open.

Fire is given by touchwood, which occasions loss of time when it fails; and danger, on the contrary, if it communicates too rapidly. To remedy these evils, the author of the present communication has tried successively the German fungus or amadou, which is steadier and more certain than touchwood. The straw may be thrust through a hole in this fungus, which burns slowly, but with certainty, and is not blown out by the wind.

This German match is merely the fungus of the ash-tree, macerated and hammered until it becomes as flexible as a piece of buff-leather; and has obtained its name from its general use on the Upper Rhine, where, by its means, habitual smokers of tobacco can light their pipes in the open air, whatever may be the weather: and as a piece which scarcely weighs four grains, is sufficient to light the largest mines without danger, while the article is by no means dear, and always safe, inextinguishable, and regular in its burning, nothing can be more useful to the practical miner.

Stemming with loose sand, which has been lately recommended in a Dublin paper, will not, it is thought, succeed in mines upon a large scale.

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*A Memoir on taking the Levels of the whole Surface of France. By* P. S. Girard, *Chief Engineer of Bridges and Highways.—Jour. des Mines,* vol. xvii.

The method by which geographers determine the position of a place on the surface of the earth, is by ascertaining the conjunction of two rectangular co-ordinates; one of which is the arc of the meridian comprised between that place and the equator;

and the other, an arc of the circle parallel to the equator, comprised between the place and any assigned meridian; or, in other words, the position of a place is determined by ascertaining its latitude and longitude. But this method, it is manifest, takes no account of the deviations of the surface from the spherical or the spheroidal form: so that the position of any place depends in reality, on a third co-ordinate, which is supposed to be drawn perpendicular to the point of intersection of the two others.

The memoir of M. Girard is intended to recommend the level of the sea, as a proper surface from whence to measure the third co-ordinates; and to give directions for the ascertaining of the vertical elevations of places above the sea to be annexed to their latitude and longitude. He proposes that, first, the levels of the five great rivers of France should be taken, as a basis for the operations; then the levels of the streams which supply those rivers; and that, in order to save expense to the French nation, the engineers of bridges and highways should be employed in the work. Processes like those suggested by this writer would certainly, if generally adopted, add much to our knowledge of the natural geography of countries; but as his particular directions are applicable to France alone, we shall not detail them at length.

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*Observations.*—We have the authority of at least two writers of the present day (viz. Mr. Gregory, *Mechanics*, vol. i. p. 492, and M. Hauy, in his elegant and useful *Traité elementaire de Physique*, tom. i. p. 241), for affirming that the notion of determining the position of places by three rectangular co-ordinates is originally due to that distinguished philosopher M. Laplace. And it appears that M. Girard's memoir is little else than a dilated representation of Laplace's directions, with this exception, that the barometrical observations recommended by Laplace are not at all noticed in the subsequent precepts. It is, we think, not a little singular that M. Girard, himself an author of some eminence (see his curious work on the Resistance of Solids), should avoid ascribing the prior suggestion of this method to his truly learned countryman: the honour of the invention of a method so remarkably obvious, would scarcely, we should have thought, have tempted a person of less merit than M. Girard to suppress an acknowledgment intentionally.

# CHEMISTRY AND MINERALOGY.

*On the Making of Wine. By* M. P. Dispan.—*Ann. de Chim.* No. 168, *tome* 56.

The phenomena which take place in the ripening of grapes are first examined by the author.

From the very first the grapes are acid; their acidity increases as they grow; but during the ripening it decreases. The juice of green grapes required $\frac{1}{25}$ of potash to saturate it; that of ripe grapes only required $\frac{1}{100}$. And again, the juice of 10 green grapes required 30 drops of a solution of potash, while 10 others, nearly ripe and much larger, required only 17.

The acids also vary according to the kinds of grapes which are examined. The juice of 10 grapes, called at Toulouse Bouisselets, perfectly ripe, required 8 drops of the solution of potash; while 10 grapes of the kind called Mausac took only 8. Both the juices were of equal strength according to the hydrometer. The acids thus present in the juice of grapes are the tartarous and the malic; to which is to be added, the acidulous tartarite of potash.

The superior specific gravity of must above water is usually attributed to the sugar it contains, and the strength of the future wine is calculated upon this idea. An hydrometer is used to determine the specific gravity of the must, and M. Dispan found by experiments that each degree of this instrument corresponded to the addition of $\frac{1}{60}$ part of sugar to the water. He also found that the juice of grapes, expressed as soon as it could be obtained from them, shewed 4°: he thinks that it is impossible that this juice could contain $\frac{1}{15}$ of sugar; at the same time, however, it doubtless contains some portion, for it began to ferment; it is therefore probable that the acids have some share in augmenting the specific gravity of the liquor. On the 17th Thermidor, year xi. he began a series of experiments on the specific gravity of the juice of grapes; at that early period the juice was with difficulty expressed. Examined by the hydrometer it marked 4°

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|---|---|---|---|---|---|---|
| the 21. | — | — | — | — | — | $3°\frac{1}{2}$ |
| 24. | — | — | — | — | — | 4° |
| 30. | — | — | — | — | — | $3°\frac{3}{4}$ |

the 3. Fructidor: examined by the hydrometer it marked $3°\frac{1}{4}$
5. (the grapes began to turn red) — — $4°\frac{1}{2}$
6. — — — — — $6°\frac{1}{2}$
8. — — — — — $6°$
11. — — — — — $7°$
13. (the grapes quite black) — — — $8°$
18. — — — — — $9°\frac{1}{2}$
23. — — — — $9°\frac{1}{2}$ to $10°\frac{1}{2}$
29. (the better kind of grapes) — $10°$ $11°\frac{1}{2}$
(a bad sort, but a great bearer) — — $8°$
2. complementary day
(different kinds) — $11°\frac{1}{4}$ $12°\frac{1}{4}$ $13°$
(another bad sort) — — $9°\frac{1}{2}$
6. (different kinds) — $11°\frac{1}{4}$ $11°\frac{1}{4}$ $12°\frac{1}{2}$
11. Vendemaire — — — — $12°\frac{1}{2}$
12. The vintage took place.

The strongest must examined was 13°, which answers to something more than $\frac{1}{5}$ of sugar, and agrees very well with the quantity of brandy which is made from the wine: and although the specific gravity may not entirely depend on the quantity of the sugar, yet it is probable that they are proportional to one another. Different kinds of grapes, equally ripe to the taste, gave very different musts, from $8°\frac{1}{2}$ to $11°\frac{1}{2}$; and the juice of the bousselet grape, and of the mausac, which, as is above stated, contained different quantities of acids, appeared of equal strength by the hydrometer, viz. $11°\frac{1}{2}$. It would therefore be proper to examine the juice of the several kinds of grapes in the vineyard when ripe, and to replace the poorer kinds by those which gave a richer must. As all the grapes in a vineyard are expressed together, the must is of a greater specific gravity as the better kinds of grapes abound. The mean specific gravity at Flourens was 10°, at Cugny it was 11°, and agreeably to this difference, the wine of Cugny is esteemed superior to the other.

It is also of consequence that the farmer should diminish as far as possible the quantity of unripe grapes; by endeavouring to get them to ripen all at one time, and by putting off the vintage as long as he can. The juice of the unripe grapes does not form wine, and is furthermore a certain agent in its destruction.

White wine is very different from red. The white ferments without throwing down a sediment, or at least without yielding a thick one, and also in small quantities. Hence the fermentation is slow and imperfect, some sugar remains unfermented, but the sweetness thus produced is relieved by the carbonic acid which is retained in the liquor; and still more by the fixed acids. At last, however, the fermentation is finished, the carbonic acid exhales, and leaves the wine flat, the fixed acids are changed into the acetous, and the wine turns sour. These inconveniences are not much felt, because the white wine is usually drank while

new and upon the spot; but M Dispan found that they might be avoided, and that a very agreeable white wine might be made by well managing the carbonic acid, excluding the air, and moderating the fermentation.

To acquire a more perfect knowledge of fermentation, M. Dispan made experiments on the juice expressed from grapes at different periods, observing to filter the juice, and to ferment it in vessels of white glass.

The first juice that can be obtained from the grape is of $3°\frac{1}{2}$ or 4°; exposed to the sun, it slowly ferments, and the liquor loses $\frac{1}{2}°$; the fermentation then ceases. Sugar added to it renews it for some time.

This juice is turbid and colourless when expressed, but it very quickly deposits a sediment, and turns of a fine amber colour. The sediment changes equally fast from green to a reddish colour: the same change also takes place in the stalks and skins from whence the juice was taken. The juice, notwithstanding these appearances, did not absorb any measurable quantity of air, not even by agitation with it.

The juice of the greenest grapes with its sediment has the same smell as that of bruised ripe grapes; on being filtered it entirely loses this odour, and retains only a slight smell of greenness.

Three things are constantly observed in the fermentation: the liquor becomes turbid, and deposits a small quantity of very fine sediment, which changes from white to brick red; the liquor loses its colour; and although it was inodorous, it contracts the smell of must. The sediment, washed with water till it no longer reddened turnsol, being added to a solution of sugar in water, of 4° by the hydrometer, caused this artificial must to ferment, so that the fermenting principle exists in the green grapes.

Must saturated with potash deposits red flocks; on adding an acid, these are redissolved, and the must ferments as usual. M. Dispan therefore means to precipitate some must by potash, to separate the precipitate by filtration, and add some acid to the filtered liquor, in order to discover whether the matter thus separated is the real fermenting principle.

As the fermentation goes on, the specific gravity of the fluid diminishes. Must fermented in a vessel almost entirely closed, but which permitted the carbonic acid to escape, was examined by the hydrometer; at first it was at 10°, 24 hours after it remained the same, but then it fell from day to day to 9°, 8°, 7°, 5°, 4°, 3°, and $2\frac{1}{2}°$. M. Dispan therefore thinks that this instrument might be useful in directing the farmer when to tun his wine.

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*Observations.*—Although the experiments of M. Dispan are not of much use in this country, on account of the vine not er-

dinarily coming to perfection, yet in some of our southern colonies they may be of considerable service.

As much benefit has been derived from the introduction of the use of the thermometer into the art of brewing, so it is probable that equal benefit would arise from joining to it the use of a hydrometer, which would enable persons to form an accurate judgment of the strength of their worts, and, as appears from the above experiments, of the progress of the fermentation, and of the most proper time to tun the liquor.

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*On making Brandy from Potatoes. By* M. GERMAIN.—*Ann. de Chim.* No. 167, *tome* 56.

POTATOES have long been used for this purpose in Germany, especially in Lithuania and the east part of Prussia, and the residue, after distillation, is found to be an excellent fodder for cattle, particularly for cows, as it increases their milk. The spirit is far superior in taste to ordinary malt spirits: it is usual to add 17½ bushels of malt to 100 bushels of potatoes, but M. Germain found 10 bushels were sufficient. This quantity, of Berlin measure, yielded 5 muids of brandy, containing from 36 to 32 per cent. of alcohol; the muid contains 240 cannes.

The same sized vessels are only necessary as for malt spirits made in equal quantity, and nearly the same quantity of fuel, as the potatoes are steamed by the vapour of the water, which is being heated for mashing, so that it is only the space of ½ or ¾ of an hour that any extra firing is required.

The potatoes are steamed in a barrel strongly hooped, placed on an open stool by the side of a still. The end which is uppermost has a square hole, fitted with a close cover, by which the barrel is filled with the potatoes; a smaller opening, with a door shutting very close, is made at the bottom of the barrel to extract the potatoes when done: there are two other holes, one to receive the nose of the still, and the other in the middle of the lower end of the barrel, to let out the condensed steam; this latter hole has a basket over it to prevent its being stopped up.

As soon as the potatoes are sufficiently steamed, which is known by taking out some of them by the door in the side of the barrel, the nose of the still is taken out of the barrel, and the potatoes are drawn out into a hopper, from whence they pass through two wooden or stone rollers that are placed horizontally near the door by which they are extracted. The rollers are turned inwards by means of a handle, and have below them iron scrapers to clear them. The bruised potatoes fall into a trough, from whence they are taken and well mixed with the mash made of ground malt.

In some places they use the yeast of beer as the ferment; in others they use artificial yeast, made of rye meal, mixed at first with cold, and afterwards with boiling water, so as to form a thick broth: some yeast of beer is then added, and afterwards the artificial, at different times, so as to keep up the fermentation. As potatoes work much easier than malt, less yeast is required, and the fermentation is very rapid; in some places a thick crust is formed.

Potatoes fermented with red beet and carrots are said to produce a greater quantity of brandy than either potatoes or beet-roots by themselves; but M. Germain is doubtful of the goodness, as it is certain that carrots added to the other substances yield a very ill-tasted spirit.

Turnip-rooted cabbage yields a very disagreeable spirit, both for taste and smell. The fermentation does not go on well, as the liquor easily turns sour, and even mouldy. The residue also must be immediately eaten up by the cattle, as it will not keep, even in winter, and they are not so fond of it as of the residue left by potatoes and red beet.

M. Germain thinks the chemists are mistaken in supposing sugar to be the only fermentescible principle, as potatoes contain only starch, and as even grain yields spirit in proportion to the quantity of starch or gluten that it contains. Neither does he think that the production of sugar in malting is of any necessity, as he says that there are many very intelligent distillers who doubt whether malted grain produces more spirit than grain which has not been malted.

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*Observations.*—The production of spirituous liquors from roots rather than corn is interesting in a political view, because the exhausting crops in agriculture ought always to be solely appropriated to the support of man, independent of the far greater produce in weight of root crops than of seed crops, so that a less extent of land need be devoted to the production of these pernicious liquors, which habit only renders necessary, and of which the use seems to be tolerated on account of the revenue drawn from them.

That sugar is not the only fermentescible principle is evident, because a solution of sugar in water does not ferment without the addition of yeast, or some similar matter, as has been repeatedly asserted by chemical authors.

How far the malting of grain tends to increase the quantity of ardent spirit has, we believe, never been accurately determined. It appears probable that unmalted grain would be too apt to run into the acetous fermentation, if used alone, for making the wort; but it is equally probable that it is by no means necessary to malt the whole of any quantity of grain intended for brewing or distilling. Dr. Thomson, in his System of Chemistry, informs us,

that it is usual in Scotland to mix two thirds of unmalted grain with one third of malt; this practice has probably arisen from a desire to evade the duty on malt. The Edinburgh Reviewers attacked this assertion with their usual asperity; but we have no doubt, corroborated as it is by M. Germain's remark respecting the doubts of the German distillers, that Dr. Thomson has unwittingly betrayed the secret of his countrymen. Experiments, however, only can decide whether the saving of the expense of malting, and the tax on that article, is not compensated by the inferior quality of the beer, or by the less quantity of the spirit which it yields.

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*Account of a Memoir, by Messrs. Fourcroy and Vauquelin, on the Phenomena afforded by animal Substances treated with nitric Acid. By* A. Laugier.—*Ann. de Chim.* No. 166, *tome* 56.

One hundred and fifty grammes of muscle heated with the same quantity of nitric acid at 32 degrees, and of water, gave 96 cubic inches of gas, containing $\frac{9}{10}$ of azote and $\frac{1}{10}$ of carbonic acid, and there was formed a yellow solution (A), having a stratum of yellow fat (B) on its surface: the residuum had not entirely lost its fibrous form.

The first washings of this residuum were yellow, and reddened blue vegetable colours; the latter washings were also yellow, but did not alter vegetable blues. The colour of the washed residuum was deeper than before; and on being moistened, it still reddened turnsol paper. The alkalies dissolved it, and formed a very deep blood-red solution, which was precipitated in yellow flocks by acids. It was greasy to the touch, had a rancid smell, and a very sharp taste; it melted on live coals, and left only a small quantity of charcoal.

This yellow substance saturated the alkalies, and neutralized them. Its combinations with potash and ammonia form a lather in water; they are not decomposed by carbonic acid, and precipitate solutions of quicksilver and of lead, in yellowish white flocks: it decomposed the alkaline carbonates with effervescence even in the cold, as also the acetate of potash, by the assistance of heat.

From the action of alcohol it appears that this yellow matter is formed of a small quantity of grease, and an acid which the authors call the yellow acid. This acid is a deeper colour than the matter from which it was separated; it had more action on turnsol paper; it did not melt in the same manner, nor exhale the smell of fat when burnt, but exhaled fetid and ammoniacal vapours. It united with fat, to which it communicated its acrid taste and rancid smell. It combines with ammonia; and it

yields by distillation, the usual products of animal substances; so that it ought to be considered as an animal acid.

The yellow residuum, treated with fresh nitric acid, at a temperature of 50°, became whitish; its specific gravity was diminished, and also its size; but no effervescence took place; nor was its acid character diminished.

The yellow solution (A) was supersaturated with carbonate of potash; it became of an orange colour, and at last deposited a yellow-red powder. On distillation a colourless liquor passed over, of a rancid odour. A similar liquor was obtained by the distillation of another portion of nitric acid employed in the decomposition of muscle; *the liquor remaining in the retort became yellow* by concentration, and its reaction on the nitric acid was evinced by the copious red vapours that it emitted; on being reduced to 40 grammes, flat needle-like crystals were formed, in a thick mother-water, which was tenacious, and appeared like gum-water.

This mother-water, which had an acid and bitter taste, became of a blood-red colour by the addition of pure potash; and, on being mixed with alcohol, it precipitated in flocks a white substance that formed fine semitransparent grains; they had an agreeable acidity, and appeared to be a mixture of sulphate of lime and of acidulous oxalate of potash. After the precipitation of these salts, the addition of lime-water gave another precipitation of oxalate of lime. The mother-water being then evaporated to the consistence of syrup was brown, viscous, and bitter; on adding alcohol it coagulated from the separation of malate of lime. The alcohol, however, still retained in solution a little nitrate of lime, a very bitter substance of a brown-red colour, and tasting like walnut-hulls, and a small quantity of the detonating substance found in indigo, which was obtained in the form of crystals by the concentration of the solution, and the addition of carbonate of potash.

Hence the authors think that muscle undergoes 3 alterations by the action of nitric acid: 1, the yellow residuum of the first operation, which, although acid, is scarcely soluble in water, and has but a slight taste; 2, the yellow substance, more soluble, bitter, and equally acid, remaining in the nitric solution; 3, the inflammable, detonating substance, which is the last term of the action of nitric acid upon muscular flesh. As to the malic and oxalic acids, the authors think they arise from the cellular tissue of the muscles, as the white membranous parts gave much of these acids, and but little of the yellow matter and of fat.

The authors indulge in many speculations on the utility of these facts in explaining the physiology of the human frame. They found that the red matter of biliary calculi separated, by means of alcohol, from the bitter and green matter, possessed the same properties as the first yellow substance obtained from muscle.

The residuum also of the urine of a young man, who had a slight jaundice, being treated with alcohol, contained this red matter alone with urea, muriate of ammonia, and acetate of soda, of which the patient made use; so that they imagine the jaundice to be caused by the superabundance of this yellow acid, which has been developed either by the oxygenizement of the muscular flesh, or of the fibrina.

They imagine an analogy exists between this yellow acid, and that which exists in rancid fats, or in those which have contracted a yellow colour by disease, or which have been treated with nitric acid.

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*Observations.*—There seems to be some error in the extract which M. Laugier has made of the original memoir, since we read, as we have marked with italics, of a yellow liquor becoming yellow by concentration. And here we cannot forbear to criticise upon the unfair practices of the French chemists, in thus publishing by their agents an imperfect account of their experiments, which leads the English and German chemists to pursue the subject farther, and to publish the result of their inquiries. In the mean time, as much as possible of this accumulated knowledge is interpolated into the original memoir, and the whole then published as the discovery of the French chemists. That Fourcroy should be guilty of such meannesses, is to be expected from the character and egregious vanity of the man; but that Vauquelin, who is to be considered as an experimental chemist of some eminence, should join his name in such disgraceful practices is a melancholy proof that the vanity of a Frenchman is superior to every other principle of action.

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## *A chemical Examination of the Gizzards of white-fleshed Poultry.* By M. Bouillon Lagrange.—*Ann. de Chim.* No. 165, *tome* 55.

The gizzards of white-fleshed poultry, when dried and pulverized, have been long used in the south of France as a specific for agues; the dose of the dried powder being about a drachm for full-grown persons, and from half a drachm to a scruple for children, taken in a glass of wine about half an hour before the fit.

In order to discover the similarity between recent gizzard and gelatine, M. Bouillon Lagrange relates a number of experiments, by which it appears the recent gizzard contains a small quantity of extractive matter, together with the acid phosphate of lime, and some traces of muriate of potash and sulphate of potash.

The dried gizzard was of a faint taste, but decidedly animal, and of a whitish grey colour. The decoction of it was slightly

yellow, smelt like chicken broth, and reddened tincture of turnsol. Lime-water, and barytic-lime-water produced abundant precipitates, partly soluble in nitric and muriatic acid. The presence of lime was shewn by the oxalate of ammonia. Oxygenized muriatic acid separated white flocks.

Nitric acid entirely dissolved dried gizzard, and, if strong, produced an effervescence; by increasing the heat, azote was separated, then nitrous gas, and carbonic acid gas. No crystals were formed in the solution by evaporation and cooling; but on distilling to dryness, a yellow, sticky, tenacious matter, excessively bitter, and also acid, was left. Water separated the acid, which was the malic.

The solutions of metals acted on the decoction of dried gizzard in nearly the same manner as on the recent, except that antimoniated tartarite of potash formed a white precipitate; neither was the precipitate by the infusion of gallnuts so abundant.

Alcohol digested upon dried gizzard acquired scarcely any colour, but it reddened the tincture of turnsol, and formed precipitates with lime-water, barytic-lime-water, and nitrate of silver.

As the action of the metallic solutions on the decoction of fresh gizzard was more or less strongly marked according to the ease with which they were able to give up the oxygen to the gizzard, M. Lagrange thought it became oxygenized in the process of drying; he therefore examined the properties of oxygenized gelatine; and he found that pure gelatine acquires different properties, according to the different processes by which it is oxygenized. The best process was to pass the oxygenized muriatic acid through a solution of gelatine. A thick white scum formed at the surface: the remainder by degrees became milky. On filtering the liquid, the white filaments which produced this milky appearance were separated, as well as the scum. They were washed both with cold and hot water, until the liquor which passed through the filter no longer changed the tincture of turnsol.

The white substance left on the filter was capable of being drawn out like gluten; it swam on water; it had scarcely any taste; it dried in the air, and took a pulverulent form; it did not redden tincture of turnsol: it did not dissolve in water, but when long boiled in a large quantity of water it was diffused through it, but separated on cooling: it dissolved in the nitric and in the acetic acid by heat, but separated from them on cooling. When triturated with pure potash, ammonia was disengaged.

Hence this substance is entirely different in its properties from either albumen or gelatine.

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*Observations.*—The great use of Peruvian bark in medicine, the increasing scarcity and consequent high price of it, has induced several persons to propose substitutes for it in indigenous sub-

stances. In our last number, p. 359, we gave an account of M. Lagrange's examination of the bark of the white willow, and of the root of geum urbanum. The present paper is similar in its purport.

As Peruvian bark contains gelatine, it has been supposed that this was the febrifuge principle; and hence some have given glue as a substitute; hitherto it should seem with little success, yet full as much as might be expected, when we consider the quantity of gelatine mankind use in their ordinary diet; but it must be owned, that if we could rely upon the success that is said to attend the use of dried gizzards, gelatine, at least when oxygenized, appears to have some febrifuge effects on the human frame. Others have suspected tannin to be the real febrifuge. In this discordancy of opinions there is reason to apprehend that no febrifuge principle, properly so called, exists; but that the power of the medicines given with that view arises from the joint operation of all or most of their constituent parts.

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*Preparation of a Varnish. By* M. PARMENTIER.—*Ann. de Chim.* No. 168, *tome* 56.

THIS varnish is used at Genoa to varnish coffee-cups made of walnut, alder, or cherry wood.

The varnish is made by boiling litharge, red lead, and white lead, of each five ounces well pulverized, in $1\frac{1}{2}$ lb. of linseed oil (the powders being tied up in a bag, and hung in the oil so as not to touch the bottom). The boiling is continued till the oil begins to grow brown; the bag being taken out, six or seven heads of garlick are then to be added, one at a time, as they dry up; and in the mean time 1 lb. of amber, with about two ounces of linseed oil, is melted in another vessel by a fierce fire. This is then added to the drying oil prepared as above. The whole is boiled for about two minutes, and then strained through a cloth.

The varnish is used with lampblack, and a little oil of turpentine; after four times going over the work, it is dried in a stove, and polished, first with pumice-stone in powder, and then with tripoli.

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*Observations.*—It does not appear that any particular utility attaches to the use of two different oxides of lead, and a carbonate of the same metal, in preparing the drying oil, since any one of them would be equally effectual. The receipts of workmen are frequently loaded with the same ingredient in different forms, which only tends to increase the expense, and to prevent the use of them in situations where all the ingredients cannot be procured.

This is scarcely worth noticing, as the use of amber varnish is well known to manufacturers, though it may be useful to persons who amuse themselves in the country, where varnish cannot be procured ready prepared.

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*Experiments on a Liquor which separated from the Caoutchouc of the Castilloya elastica of Mexico. By Messrs.* FOURCROY *and* VAUQUELIN.—*Ann. de Chim.* No. 165, *tome* 55.

ON breaking the bottle which contained the juice (which had been brought from Mexico by Humboldt and Bonpland) it was found in a concrete state, and of a greyish-white colour: when placed on a plate it contracted, and there oozed from every part a brown-red liquor, of a sharp and bitter taste, which reddened paper tinged with turnsol. The caoutchouc itself was very white, very elastic, lighter than water, and became slightly brown on exposure to the air, but less so if well washed, so that the brown colour appears to arise from the remains of the above-mentioned liquor.

This liquor did not coagulate glue; it precipitated sulphate of iron green, the acetate of lead, the nitrates of quicksilver, and of silver of a yellowish white; it was coagulated by alcohol forming brown flocks (A). Evaporated to the consistence of syrup, it communicated a red colour to boiling alcohol; on cooling, a pulverulent whitish matter separated (B). On evaporating the alcohol, more of this matter was separated in yellowish white flocks; but there remained in the alcohol a yellowish red substance (C) which did not separate.

The brown coagulated flocks (A) dissolved easily in water; the solution was not precipitated by infusion of galls. They afforded by distillation a great proportion of carbonate of ammonia, and of thick red oil; the carbonaceous residue left, on incineration, grey ashes, containing oxide of iron, silica, and a little sulphate of lime.

The pulverulent white matter (B) had no taste: it was soluble in alcohol when moist, but almost insoluble in water: it reddened tincture of turnsol; it burned like animal matters, and left no ashes; it easily combined with the alkalies, but was separated from them by the acids. The alkaline solution of it precipitated the solutions of iron of a green colour.

The yellowish red matter (C) had a very bitter taste; it was soluble in water, and the solution gave an emerald-green colour to sulphate of iron; but no precipitation took place: it quickly reddened paper tinged with turnsol: it produced an effervescence with sulphuric acid, disengaging acetic acid: this mixture was precipitated by water. The solution of it in water was coagu-

lated by nitric, muriatic, and other acids, yellowish flocks being formed. It puffed up upon live coals, and produced sharp white vapours resembling those of vegetables. Reduced to the consistence of an extract, it became much less soluble in alcohol, communicating to it only a slight colour, and the property of rendering the solutions of iron green. This extract exposed to heat, swelled remarkably, exhaled at first acetic acid, and afterwards an empyreumatic and slightly ammoniacal odour. The carbonaceous residue burnt with great ease; and being lixiviated, yielded potash slightly carbonated, mixed with muriate of potash, so that this last substance appeared to contain acetate of potash with excess of acid.

The authors suspect that not only the free acid in this liquor, but also that combined with the alkali, have been formed by the fermentation of the juice since its extraction, and that the potash being originally combined with the caoutchouc, the separation of the latter takes place from the superior attraction of potash for the acid: nevertheless they allow that some juices, which contain caoutchouc, do not contain alkalies.

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*Observations.*—The idea started in the latter paragraph of this paper seems to afford a solution of many phenomena of vegetable and animal physiology, since the formation of precipitants during fermentation must frequently take place. It is in this manner that the tartar originally contained in the juice of the grape is precipitated during the fermentation of that juice, by the diminished power of solution which the newly-produced liquid possesses.

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*On the Presence of fluoric Acid in animal Substances. By* M. Gay Lussac.—*Ann. de Chim.* No. 165, *Tome* 55.

Morichini, a chemist at Rome, having found fluoric acid united to lime along with the phosphate and carbonate of that earth, in examining the enamel of the grinders of a fossil elephant found in the neighbourhood of Rome, was led to extend his researches on the subject.

He found that 100 parts of the enamel of human teeth contains 30 of animalized matter, a little magnesia, alumine and carbonic acid, together with 22 parts of fluoric and phosphoric acids united with lime. He was not able to separate completely the fluoric acid from the phosphoric, but imagined that the last was in very small quantity. As in the experiments of Josse and those of Hatchett fluoric acid was not detected, Morichini repeated his experiments until he had no longer any doubt on the subject. As the phosphate of lime found in Estremadura, and the earth of

Marmorosch, contain fluoric acid, he imagines they may be the residue of animals.

M. Gay Lussac, by treating calcined ivory with sulphuric acid, obtained vapours which he immediately recognised for fluoric acid. The tusks of a boar, and some fossil ivory, gave the same result: so that this accurate chemist seems convinced of the truth of Morichini's assertions.

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*Experiments shewing that the Enamel of human Teeth does not contain fluoric Acid. By* W. Brande', *Esq.—Phil. Jour.* No. 52.

In order to determine whether the enamel of human teeth consisted chiefly of phosphate of lime as stated by Josse and Hatchett, or whether it contained fluoric acid as stated by Morichini and Gay Lussac, Mr. Brandé kept some of this enamel for a few minutes in a red heat, and afterwards pulverized it. It was then mixed with sulphuric acid, and exposed to heat. Suffocating fumes were extricated, but a glass rod suspended over the mixture was not corroded, neither was the plate of glass affected which covered the platina crucible.

Another portion was distilled with sulphuric acid, and the aeriform products received over quicksilver; a small quantity of sulphuric acid gas was disengaged, and what remained in the retort consisted, as far as Mr. B. could ascertain, of a mixture of sulphate of lime, phosphoric acid, and a small portion of sulphur arising from the decomposition of a part of the sulphuric acid by the animal matter existing in the enamel.

*Observations.*—We have here another instance of the uncertainty which still exists in relation to chemical analyses, as both Gay Lussac and Hatchett are well known as chemists of the greatest eminence. It is certainly very extraordinary, that Morichini, who had both Hatchett's and Josse's experiments before him, should have ventured an assertion of this kind without some foundation.

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*On the Processes used at Frederichshütte for smelting Lead Ore. By* M. Daubuisson.—*Journ. des Mines,* No. 102.

This smelting-house is situated near Tarnowitz, and it receives yearly 20,000 cwt. of galena (containing 68 per cent. of lead, and $\frac{3}{4}$ oz. of silver in the cwt.), and 4000 cwt. of washed ore (schlich), containing 40 or 45 per cent. of lead, and $\frac{1}{2}$ oz. of silver in the cwt. The several operations are as follows.

1. The smelting of the ore: each charge consists of 100 cwt. of ore, mixed with 15 to 18 cwt. of granulated cast iron, 10—12 cwt. of scoriæ from the iron forges, and 30—36 cwt. of the scoriæ of former meltings. These are fused in a blast furnace, 1,42 metre in height above the basin, previously heated for 8 hours at the expense of 3 cwt. of coal. The melting takes up 17 hours, and requires 154 decalitres of coak; it produces 66 to 67 cwt. of lead, containing an ounce of silver in each cwt. and 26 to 28 cwt. of matt, which retains 1 or 2lb. of lead. This operation is recommenced every week, and takes up about 14 or 15 weeks; after which commences,

2. The smelting of the schlich, which is performed in the same furnaces as the former, but raised to the height of 5,68 metres above the basin. Each charge consists of 100 cwt. of schlich, mixed with 8 to 10 cwt. of granulated cast iron, 30 to 32 cwt. of the matt above mentioned, 20 to 24 cwt. of the scoriæ of the iron forges, 120 cwt. of the scoriæ from the former smeltings of schlich, and 20 cwt. of the scoriæ which adhere to the bottom of the furnace in the first operation. Each smelting takes up 48 hours, and requires 40 cwt. of coak; it produces 40 to 44 cwt. of lead, containing $1\frac{1}{2}$ oz. of silver. The operation is recommenced every fortnight, and lasts in the whole eight weeks.

3. The smelting of the slags and other residues of the former operations:—viz. the matt of the first operation, not employed in the second, the slags adhering to the bottom, or sides of the furnaces, and the scoriæ obtained in smelting the scoriæ produced in reviving the litharge, &c. The charges are various, in general they consist of 50 cwt. of slags detached from the bottom of the furnace, 25 cwt. of scoriæ from litharge, &c. 30 cwt. of matt, 15 cwt. of slags from the sides of the furnace, and 10 cwt. of the scoriæ of iron forges. This charge yields $3\frac{1}{2}$ cwt. of lead, containing 1 oz. of silver in the cwt. The smelting lasts 15 days, 77 cwt. being smelted every 12 hours; each 100 cwt. of the charge requires 8 cwt. of coal.

4. The testing of the lead obtained is not yet brought to perfection. They formerly used the English method, in an elliptical test of bone-ashes, capable of containing 5 cwt. of lead; about 30 cwt. were tested in each operation. The testing of 140 cwt. took up $4\frac{1}{2}$ days, required 6 cwt. of bone-ashes, and consumed 84 cwt. of coal. At present they use a test of wood-ashes, formed of 1050 to 1260 litres of ashes, and test the lead twice over. In each operation they employ about 160 cwt. of lead. In the first testing, from 145 to 150 cwt. is reduced to litharge, the coal consumed is 33 cwt. the test left weighs about 34 cwt. and the remaining 10 to 15 cwt. of lead hold about 2 marks of silver in the cwt. In the second testing a like quantity of about 160 cwt. of *rich* lead is employed,

and there is left on the test a cake of about 300 marks of silver, containing about $\frac{1}{16}$ of alloy.

5. The litharge is revived in a blast furnace, from 3 to 400 cwt. in each operation: 100 cwt. of litharge requires 7 hours for its reduction, 24 cwt. of coal being consumed in this space of time; it yields about 91 cwt. of lead, containing not more than $\frac{1}{32}$ oz. of silver, and 30 cwt. of scoriæ, which are rich in lead.

6. The test, the scums produced in the testing, and the ashes left on the test, are reduced by themselves, on account of their superior richness. The scoria of the first operation is added in this reduction, the proportion of the ingredients being various: 100 cwt. of charge is smelted in 14 hours, 36 cwt. of coal being consumed in that time: this yields 66 cwt. of lead, containing from $\frac{1}{2}$ to 1 oz. of silver in the cwt. and about 70 cwt. of scoriæ, which retain about 5 or 6 lb. of lead in the cwt.

7. The scoriæ of the two former operations are reduced separately in high furnaces, as in the second operation: 100 cwt. of the scoriæ mixed with the slags adherent to the bottom or sides of the furnaces is mixed with 10 cwt. of the scoriæ of iron forges, 10 cwt. of matt, and 5 cwt. of limestone. This charge is melted in 16 hours, with 30 cwt. of coak: 100 cwt. of scoriæ of the reduction of litharge with the slags yield from 24 to 25 cwt. of lead for sale, containing less than $\frac{1}{16}$ of silver in the cwt.; 100 cwt. of scoriæ of the reduction of the test, &c. yield from 10 to 12 cwt. of lead, to be worked over again, containing $\frac{1}{2}$ oz. of silver in the cwt. The reduction of these scoriæ yields about 100 cwt. of other scoriæ, which contain about 1 lb. of lead in the cwt.; they are smelted with the slags and other residues as above.

8. The refining of the silver is performed in a reverberatory furnace, on a test of bone-ashes. About 300 marks, viz. the cakes left in the second testing, are refined at each time: the alloy is by these means reduced to $\frac{1}{50}$ of the mass; 100 marks of silver require about 1½ cwt. of coal for the refining, and it is computed that 180 marks can be done in 4 hours.

The whole charge of separating the silver from the lead by these operations is computed at $\frac{1}{30}$ part of the value of the silver. This suite of operations on the above quantity of materials lasts near a year; what little time may remain is employed in making trials to improve the processes.

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*Observations.*—The principal thing to be remarked in this method is the custom of performing each series of operations at different times of the year, and thus employing the same furnaces for several successive operations.

The schlich mixed with the ore in the first melting is collected

from the same ore, which had been stamped, and then exposed to the action of currents of water of different force, directed by a peculiar apparatus, which is described at full length in a former number of the Journal des Mines.

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*On a particular Process used in the County of Eiffel, for refining Iron. By* A. H. DE BONNARD.—*Journ. des Mines*, No. 102.

THIS method is called by the natives the *Méthode de la Vallée de Schleyden*, and is used in about 17 iron furnaces, which are besides remarkable for the number of shares into which the property in them is divided. The refining of the iron is begun in the smelting furnaces, which are about 20 feet in height, and of the usual construction. The ore is extremely fusible. In general the furnace is charged in the space of 24 hours with from 3000 to 3600lbs. of charcoal, and from 4650 to 5580lbs. of ore. When the basin is full of the melted metal, a bar is passed through the blast-hole, some of the slag is raised up from the surface, and being cooled by the blast is dextrously shaped, so that the blast striking against it may be reflected upon the melted metal. The slag is removed as it is formed, and the iron is kept boiling from 1 to 5 hours, until it begins to emit a great number of sparks. In the mean time, the mould is prepared, formed principally of charcoal powder, and so extremely moist, that when the metal is let out of the furnace it frequently explodes, and produces accidents: if it does not, it is immediately covered with charcoal powder, and plentifully sprinkled with water. It is then carried to the finery, and formed into cakes of from 50 to 80lb. which are afterwards forged. In this method, about 4,3 parts of charcoal are required to form one part of forged iron.

M. Bonnard observes, that this operation is performed on the same principle as the English method, and he thinks that the respective merits of the English process, and of the present, can only be determined by local circumstances; since although the English method must consume a larger proportion of fuel, yet the furnace being kept constantly in full action, it allows a greater quantity of iron to be produced. In the furnaces of Eiffel, the produce is only about 50,000lb. a month.

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*Examination of (Fahlerz) grey Copper Ore. By Prof.* KLAPROTH. —*Journ. de Phys. Vendem.* xiv.

THIS mineral is sometimes called grey silver ore on account of the superior value of that metal. As some other ores are nearly similar in appearance, Mr. Klaproth relates from Karsten the external characters by which they may be distinguished, and exhibits their analyses.

The analysis of ores, containing sulphur and arsenic, is extremely difficult to be effected by means of solvents, and therefore the grey copper ore from a mine near Freyberg was distilled per se; it yielded sulphur and realgar, the residue was mixed with $\frac{1}{2}$ of charcoal, and again distilled; it now yielded metallic arsenic. The residuum was then calcined; nitrous acid dissolved it almost entirely, leaving only a small residuum. Muriatic acid poured on this sediment took up the oxide of iron, and left some charcoal powder. The muriatic solution was poured into the nitric; muriate of silver was precipitated. Sulphuric acid was poured into the mixed solution, and the whole evaporated to dryness. The residuum was totally soluble in water, and therefore did not contain lead. The solution was supersaturated with ammonia, which precipitated an oxide of iron. The ammoniacal solution was supersaturated with sulphuric acid, and the copper was precipitated by digestion with a bar of zinc. The sulphur that rose in the preliminary operation along with the arsenic was separated by an alkaline lye, which dissolved the sulphur, and left the metallic arsenic.

Three specimens were analysed, drawn from three different mines near Freyberg. They contained as follows:

| | No. 1. | No. 2. | No. 3. |
|---|---|---|---|
| Copper | 41, | 48, | 42,50 |
| Arsenic | 24,10 | 14, | 15,60 |
| Iron | 22,50 | 23,80 | 25,50 |
| Sulphur | 10, | 10, | 10, |
| Silver | 0,40 | 0,50 | 0,90 |
| Antimony | | | 1,50 |
| Loss | 2, | 2, | 2, |
| | 100 | 98,30 | 98, |

Hence it appears, that copper, arsenic, iron, and sulphur are the essential ingredients in grey copper ore.

Black silver ore has been confounded with grey copper ore, but is separated by Mr. Klaproth, who calls it graugiltegerz. Exposed upon charcoal to the blow-pipe, it crackles and flies about, but soon melts, throwing out a white antimonial smoke, and yields a portion of black copper. A little nitre added to the globule causes it to detonate. By remelting the globule with borax, red copper may be obtained.

This ore was digested with nitric acid; from the portion that was taken up, muriatic acid precipitated a little muriate of silver. The remaining solution was then divided into three portions.

The first portion was evaporated to dryness, and redissolved in very dilute sulphuric acid; the limpidity of the solution shewed that no lead was contained in the ore. The solution was supersaturated with ammonia, which precipitated a brown oxide. This oxide was redissolved in muriatic acid, and the iron precipitated by an alkaline prussiate; the remaining solution was heated, and

again precipitated by an alkaline carbonate, which threw down an oxide of manganese, as appeared by its colouring phosphate, and nitrate of potash, violet when melted with them. The ammoniacal solution from whence these oxides had been precipitated, was supersaturated with sulphuric acid, and the copper it contained was precipitated by a polished plate of iron.

The second portion of the nitric solution was boiled for some time with caustic potash; on cooling, an oxide of copper mixed with iron was separated. Muriatic acid was added to the solution, and the whole heated to ebullition; an alkaline carbonate now threw down an oxide of zinc.

As it was suspected that the sulphur was partly decomposed by the nitric acid when the mineral was digested with it, acetate of barytes was added to the third portion, and sulphate of barytes was thus formed and precipitated.

The undissolved residuum left by the ore when digested with acid gave a straw-coloured solution with muriatic acid, and left some sulphur with a little copper, which were separated by combustion and reduction. The solution was evaporated, and divided into three portions.

The first portion was diluted with water, and its limpidity preserved by more acid; sulphuretted ammonia was then added, which precipitated sulphuretted oxide of antimony.

The second portion was also much diluted, and let fall the white oxide of antimony: the remaining liquor was saturated with an alkaline carbonate, which precipitated more oxide of antimony.

The third portion was diluted with water, and more acid added to preserve its limpidity; the antimony was then precipitated by zinc.

This ore distilled with iron filings did not yield any quicksilver. Crystallized black silver ore from Kapnick thus analysed yielded 37,75 of copper, 22,0 of antimony, 5,0 of zinc, 3,25 of iron, 28,0 of sulphur, 3,25 of silver and manganese, 2,75 being lost.

Another specimen from Poratsch, in Upper Hungary, called by Linnæus Hydrargyrum crepitans, yielded 39,0 of copper, 13,50 of antimony, 7,50 of iron, 6,25 of quicksilver, 26,0 of sulphur, 1,75 being lost. (N. B. The sum is only 94.)

An amorphous specimen from Annaberg yielded 40,25 of copper, 0,30 of silver, 23,0 of antimony, 13,50 of iron, 18,50 of sulphur, 0,75 of arsenic, 3,70 being lost.

A crystallized specimen from Zille, near Clausthal, yielded 37,50 of copper, 3,0 of silver, 29,0 of antimony, 5,50 of iron, 21,50 of sulphur, 2,50 being lost. (N. B. The sum is only 99.)

Another crystallized specimen from Saint Venzel, near Wolfach, yielded 26,0 of copper, 13,25 of silver, 27,0 of antimony, 7,0 of iron, 25,50 of sulphur, 1,25 being lost.

A specimen from Cremnitz, in Hungary, according to a former analysis, yielded 31,36 of copper, 14,77 of silver, 34,09 of an-

timony, 3,30 of iron, 11,50 of sulphur, 0,30 of alumine, 1,60 being lost.

Hence it appears, that copper, antimony, iron, and sulphur, are the essential ingredients in this mineral, and that the silver, although it enters in a considerable portion into some varieties, is only accidental.

Another species of mineral has also been confounded with grey copper ore, but which ought in fact to be considered as an ore of lead. This is called by Karsten spiesglanz-bleierz (*i. e.* antimonial lead ore), and he says it is of a lead-grey colour, it has little or very little metallic lustre. Its fracture is unequal, with coarse grains, it is soft, and nearly very soft, it is found massive or disseminated, it is sectile, its specific gravity is considerable.

By analysis it yielded 42,50 of lead, 19,75 of antimony, 11,75 of copper, 5,0 of iron, 18,0 of sulphur, 3,0 being lost.

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*Observations.*—This celebrated professor (whose recent death every friend to chemistry must deplore) here distinguishes three species of ore which had been confounded.

The mineralogical characters of fahlerz, or grey copper ore, are well known; those of the second kind, called by Klaproth grau-gultigerz, which is rendered above black silver ore, may be found more at large in Jameson's Mineralogy, under that name. The last species, or spiesglanz-bleierz, is, we believe, the triple sulphuret of lead, antimony, and copper, described by Bournon, and analysed by Hatchett (Phil. Trans. for 1804), which is mentioned by Jameson under the name of Bournonite. It has hitherto been found only in the mine called Huelboys, in Cornwall.

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*Experiments on a mineral Substance, formerly supposed to be Zeolite; with some Remarks on two Species of Uran-glimmer. By the Rev.* William Gregor.—*Phil. Trans.* 1805. Part ii.

This mineral is raised in a mine called Stenna Gwyn, in the parish of St. Stephen in Bramwell, in the county of Cornwall. There are two varieties of it. The first variety forms divergent tufts of minute crystals adhering to quartz. The crystals are white, sometimes stained of a yellowish hue, they are transparent, and seldom exceed a quarter of an inch in length. They seem to be rhomboidal prisms, with the angles worn away. Imbedded among these crystals the two varieties of uran-glimmer hereafter described are found.

The second variety consists of an assemblage of crystals compacted together in the form of mamillary protuberances, generally of the size of small peas, intimately connected with each other. A stratum of these, about $\frac{1}{8}$ of an inch thick, is spread

upon a layer of quartz, in the cavities or fissures of a species of compact granite.

The detached crystals of the first variety yield a brilliant white powder; its specific gravity at 56° was 2,22. The more compact variety scratches calcareous spar; its specific gravity at 55° was 2,253. It does not imbibe water. Exposed to a sudden heat, the crystals decrepitate, but when gradually heated, they grow opake, and become more light and tender; but they are infusible. Phosphate of soda and ammonia take up this mineral without effervescence, but it swims about the globule unaltered. Borax dissolves it, and the globule remains transparent. The powder of this mineral does not form a coherent mass with pounded quartz. Sulphuric acid does not effervesce with it, nor disengage any vapour; when heat was applied, the mineral was dissolved, and a plate of glass placed over the mixture was not dissolved. When the crystals were distilled a liquid passed over, which had a peculiar empyreumatic smell: a slight whitish crust was also sublimed into the neck of the retort.

This mineral exposed to a red heat lost $25\frac{5}{6}$ per cent. of its weight; a stronger heat for more than an hour made another portion lose $30\frac{3}{4}$ per cent. The cover of the crucible gave some indications as if a slight portion of the finer parts had been volatilized.

Sulphuric, nitric, and muriatic acids, aided by heat, dissolve this mineral; the undissolved residuum is diminished in proportion as the mineral is more pure. Neither nitrate of silver nor muriate of barytes produces any change in the nitric solution. Neither the muriatic nor nitric solutions can be brought to crystallize.

The powder remaining after exposure to heat retained its pure whiteness, and on being analysed yielded as follows: 50 grains lost at first 15 $\frac{3}{8}$ of volatile matter, the remainder contained $29\frac{11}{12}$ of alumine, $3\frac{1}{16}$ of silica, $\frac{3}{16}$ of lime, $\frac{3}{32}$ of oxide of iron, so that $2\frac{15}{16}$ ($1\frac{30}{32}$?) were lost. The silica and lime appear to be essential ingredients, as they are always found. Great difficulty was experienced in this analysis in bringing the last portions of the solution to crystallize into alum. This Mr. G. thinks is owing to a peculiar combination that takes place between the sulphate of alumine, the lime, silica, and potash.

The volatile ingredients of this mineral appearing worthy of particular attention, a fresh portion was distilled.

The liquid that passed over had an empyreumatic smell resembling that of the liquid distilled from the white crust that surrounds common flint. It changed litmus paper to a faint reddish hue. It produced no change on nitrate of silver, and scarcely any perceptible effect on nitrate of quicksilver.

The crust formed in the neck of the retort consisted of thin scales, some of which were more disposed to separate from the glass

than others. They were opake like white enamel, and reflected the colours of the rainbow. On their being moistened with sulphuric acid, no vapour arose. By the blow-pipe upon charcoal they first turned black, and then melted into a globule, that exhibited somewhat of a metallic splendour, which soon grew dull. This substance is soluble in water, which on evaporation assumes on the edges a saline appearance; but as the moisture evaporates, it becomes earthy, opake, and white. The solution changes litmus paper to a faint red. Lime and strontian waters produce white clouds in it, which a drop of nitric acid removes. The muriates of lime and barytes produce no change in it. Nitrate and acetate of barytes disturb its transparency; nitrate of silver produces no effect; but the nitrates of quicksilver and lead produce precipitates, soluble in nitric acid. Phosphate of ammonia and soda produced a white precipitate. Oxalate, tartrite, and prussiate of potash, did not affect it, nor did sulphate of soda. When ammonia was dropped into it, the fluid preserved its transparency; but carbonate of ammonia produced a white precipitate, which was not redissolved by an excess of the carbonate. This precipitate was not soluble in a concentrated solution of potash; but when it was dissolved in nitric acid, no precipitation was caused by the addition of potash.

Carbonate of potash produces a white precipitate with the aqueous solution of this scaly sublimate; the supernatant fluid became turbid on evaporation. The same effect takes place when carbonate of ammonia is used as the precipitant. The precipitate by the carbonate of potash, on being dissolved in sulphuric acid, produces crystals, some of which resembled alum, but others seemed to differ from it. The solution of these crystals was decomposed by ammonia, and potash dissolved the precipitated earth; but the quantity was too small for further experiment.

The watery solution of the scales was decomposed by nitrate of lead, and sulphuric acid was poured upon the edulcorated precipitate; the sulphate of lead was separated by the filter, and the filtrated liquor was evaporated; small crystals were formed, whose form could not be ascertained. When exposed to the blow-pipe in a gold spoon, they did not burn to coal, nor give out any empyreumatic smell, nor melt, but they assumed an earthy appearance.

If what adheres to the neck and cavity of the retort be dissolved in water, the solution is found to differ from that of the sublimate, inasmuch as it contains lead. If nitric or muriatic acid be poured into the retort to dissolve what still remains adhering to it, the presence of lead is still more evident. The metal seems to arise from the glass being corroded by the acid of the mineral. Yet this acid does not seem to be either the phosphoric or the fluoric; and, although it is supposed to be of vegetable origin, it does not seem to be the oxalic.

Mr. G. found that the Barnstaple mineral, analysed by Davy (see our first volume, p. 184), and which is supposed to be identical with the present fossil, yielded the same volatilized saline crust.

*On the Uran Glimmer that accompanies this Fossil.*

The first variety of uran glimmer consists of parallelopipedon plates, with truncated angles, applied to each other, and is of a green colour of various tints from emerald-green to apple-green.

The second variety consists of square plates, which vary in thickness; the angles of the several square laminæ, which are applied to each other, are not always coincident. The sides of the largest of these laminæ is about a quarter of an inch: they are of a bright wax yellow, and are frequently found adhering to the sides of quartz crystals in the cavities of granite.

The specific gravity of these yellow crystals, at 45°, was 2,12. Exposed to the blow-pipe, they decrepitate violently. This substance is taken up by the phosphate of soda and ammonia without effervescence, and it communicates a light emerald-green to the globule. By exposure to a red heat it loses about one third of its weight, and becomes of a brassy colour. It is soluble in the nitric and muriatic acids; but these solutions do not yield any crystals. The nitric solution is precipitated by ammonia in white clots mixed with some of a yellowish hue. When the ammonia was added in excess, no signs of the presence of copper were observed. The ammonia on evaporation was found to hold a portion of the mineral in solution. Fresh portions of ammonia dissolved more, but in a less quantity at each succeeding effusion. The scarcity of the mineral did not allow Mr. G. to make a rigid analysis of it; he, however, detected the presence of oxide of lead, lime, and silica, in it, which have not hitherto been considered as ingredients of uran glimmer: but the substance which is dissolved by ammonia has some properties which seem to distinguish it from uranium.

This substance amounts to nearly $\frac{1}{6}$ of the fixed ingredients; it is white, inclining to ash-colour. It tinged phosphate of soda and ammonia of a light green. It was soluble in sulphuric acid, except a few gelatinous flakes. The solution was greenish, and by evaporation formed minute stellated crystallizations, which were in general colourless, but a few were tinged of a smoke-colour: these crystals were deliquescent. Upon evaporation, the same crystallizations were produced. After a time, some detached, regular, permanent, and colourless crystals were formed, whose figure could not be ascertained. On being exposed to a red heat no ammoniacal vapour was perceptible; and they melted into opake globules, which fell to pieces in water, and formed white gelatinous flakes. The supernatant water produced a cloud with muriate of barytes; but neither ammonia nor prussiate of potash caused any change in it.

It is soluble also in nitric acid, forming a confused crystallized mass, which soon deliquesced. Zinc immersed in this solution precipitated white gelatinous flakes. Iron caused no change. Ammonia and potash threw down white precipitates; a portion of which were re-dissolved. The alkaline carbonates produced white precipitates. Prussiate of potash precipitated the solution in distinct flakes of the colour of mahogany; and the solution of galls in alcohol precipitated a light yellow powder.

It is soluble also in muriatic acid, forming a very dilute green solution. It requires an excess of acid to hold the substance in solution. The solution, after a time, deposits yellowish crystalline grains, which require a large quantity of water to dissolve them.

It is not soluble in acetic acid.

The green crystals differ in no respect from the yellow, except in containing a little of the oxide of copper.

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*Observations.*—The great scarcity of all the fossils here treated of would render the detail of their properties and habitudes of little value to practical men, did not the one seem to contain a new mineral acid, and the others a new metallic substance.

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*On Uranium. By* M. Bucholz. *Extracted from Gehlin's Jour. der Chem. by Vogel, in Ann. de Chim.* No. 167, *Tome* 56.

The author obtained the uranium he made use of, by treating a black mineral, containing it, with nitric acid, and evaporating it to dryness. On washing the residuum there was left undissolved red oxide of iron, silica, and sulphur; the liquid containing the nitrates was again evaporated, heated to redness to decompose the nitrate of iron, and re-dissolved. Oxide of iron was left on the filter. Ammonia was added in excess to the greenish yellow solution, and the mixture digested for 24 hours; the fine blue supernatant liquor was decanted, and the precipitate was washed. This precipitate was of a fine yellow colour, but contained ammonia, which was expelled by calcination, a greenish yellow oxide of uranium being left, which contained 7 per cent. of lime; that was, of course, united with the oxide, otherwise it would not have been precipitated by ammonia. This lime could not be properly separated by means of an alkaline oxalate, because the oxalate of uranium is itself scarcely soluble. The author therefore dissolved the impure oxide in nitric acid, and separated the two nitrates by repeated crystallizations, the nitrate of lime remaining in the mother-water.

Oxide of uranium separated from the nitrate by potash, was formed into a globule with white wax and 20 per cent. of fluate of lime, carbonate of lime, and charcoal powder. This mixture,

exposed to the most violent fire, did not produce a perfect metallization: 100 grains of oxide of uranium and 5 grains of charcoal, exposed for three hours to the heat of a forge, agglutinated into a mass, lost two thirds of its volume, and became of an iron-grey colour. By the help of a magnifying glass, fine needles of a feeble metallic lustre were perceived in it. It absorbed much water, and its specific gravity was 9,000, and would probably have been more, if the mass had been compact and properly melted. It dissolved in nitric acid, and disengaged nitrous gas. Heated in a crucible, it took the form of a blackish grey powder, and its weight was increased from 5 to 25 per cent.

Metallic uranium is not acted upon by sulphuric acid if diluted; but when that acid is concentrated, and boiling, it acts slightly upon this metal, disengaging sulphurous acid gas. Muriatic acid also has but a slight action on uranium, although it dissolves so much, that when the solution is evaporated, and the residuum heated to redness, oxygenized muriatic acid is disengaged, and there remains a black grey oxide *ad minimum*, which contains 5 or 6 per cent. of oxygen, and becomes yellow by exposure to the air. Salts of uranium cannot be obtained from either of those acids. The oxide of uranium *ad maximum* is prepared by decomposing nitrate of uranium by potash. This oxide is citron yellow; it contains 20 to 24 per cent. of oxygen, and does not become acid by cohobating nitric acid upon it.

Neither potash, nor the carbonate of potash, dissolves the oxide of uranium when it has been dried; but when added in excess to a salt of uranium, they partly dissolve the precipitated oxide, and particularly the carbonate has this effect. The same thing not only happens with ammonia, but the oxide also becomes browner, and appears to pass into the state of an oxide *ad minimum*. Oil olive also disoxygenizes the yellow oxide of uranium, and renders it brown; the oil becomes thick.

Oxide of uranium (obtained by the calcination of the nitrate), when boiled with diluted sulphuric acid, evaporated and redissolved, gave a greenish yellow solution, which crystallized by spontaneous evaporation, and formed citron-yellow crystals, that had the very rare form of pentangular pyramids. Exposed to a white heat it did not melt, but was decomposed, and lost 36 per cent.: there remained a black oxide, which being dissolved in nitrous acid, did not retain any sulphuric acid.

The crystals of the sulphate, on being exposed to the air and the rays of the sun, lose their transparency, but do not effloresce. They dissolve in $\frac{5}{8}$ of their weight of water at 15°, forming a thick syrup-like solution. They dissolve in 25 parts of alcohol, and this solution undergoes some remarkable changes by the rays of the sun. The yellow liquid deposits a greenish grey matter, and acquires, in a few days, a smell of ether, but more resembling nitric ether than sulphuric: the liquor contains disengaged sul-

phuric acid, and, after being filtered, is as clear as water, and does not contain any metal in solution. The precipitate, which is green, contains sulphuric acid.

One hundred grains of the sulphate, dissolved in water and precipitated by muriate of barytes, yielded 56 grains of dry sulphate of barytes. Another 100 grains, dissolved in water and precipitated by potash, yielded a precipitate weighing 70 grains. The salt also lost 12 per cent. by a slight calcination; so that the sulphate appears to be composed of 18 parts of sulphuric acid, 70 of oxide of uranium, and 12 of water.

Oxide of uranium, dissolved in nitric acid and evaporated by the heat of a stove, yielded rectangular quadrangular pyramids an inch and a half in length. The colour of this salt is variable; it is of a citron-yellow brown, with greenish edges; sometimes it is darker. By a slight calcination they turn to a yellow powder, and lose 14 per cent. of their weight: 100 grains of the dried nitrate, dissolved in water and precipitated by potash, gave 61 grains of washed and dried precipitate; from whence we may conclude, that it is composed of 25 parts of nitric acid, 61 of oxide of uranium, and 14 of water.

Nitrate of uranium exposed to heat melts by reason of the water it contains; it then becomes solid again, grows red, and gives out oxygen and nitrous gas. There remains a yellow-brown matter, so far disoxidized, that when it dissolves in nitric acid it disengages nitrous.

Nitrate of uranium, in a dry air and a heat of 20°, is efflorescent; but in a moist cellar it deliquesces. It dissolved in $\frac{1}{2}$ its weight of water. One part of alcohol can dissolve $3\frac{1}{3}$ parts of this salt; by a slight heat a part of the nitrate in this solution is decomposed; an oxide is precipitated, and ether is formed. The nitrate is also very soluble in sulphuric ether, forming a yellow solution, which, exposed to the sun's rays, becomes green, acquires the smell of nitric ether, a black matter being precipitated.

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*Observations.*—The ore used by the author was probably the pechblende of the Germans, or the urane oxydulé of Hauy, which is the only black mineral containing it. Hitherto this metal is very scarce, and therefore we think it necessary to relate the characters by which the ore above-mentioned is distinguished from those minerals with which it might be confounded. These analogous minerals are common blend (or black jack) and wolfram. From the former of these it differs by being rather heavier, and by yielding a blackish powder; whereas that of common blend is grey. The laminæ in common blend are situated in various directions; those of pechblende, on the contrary, lie in only

one direction. The powder of wolfram is brown, inclining to violet; and the mineral may also be divided with smooth surfaces in two directions, one of which is perpendicular to the other.

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*On the Oxidizement of Metals, and on the Oxidizement of Iron in particular. By* M. THENARD.—*Ann. de Chim.* No. 166, *Tome* 56.

IT is known that combustible bodies combine with different quantities of oxygen; and hence Berthollet has been led to infer, that there exists an infinite number of degrees between the maximum and the minimum of oxidizement. Although the author thinks there are a much greater number of metallic oxides than is usually admitted, he is far from supposing that there are as many oxides as there are possible degrees of oxygenizement; for if there were, why do the oxides always exist in a peculiar state in their combinations with acids? The analogy also, with sulphur and phosphorus, which form peculiar acids, with a determinate dose of oxygen; and of hydrogen, which forms water also, with a determinate proportion of oxygen, is greatly in favour of the opinion, that there exist certain stages, as it were, of oxidizement in metallic oxides.

Even, if it is any ways doubtful as to the oxides themselves, still we must admit this opinion in respect to metallic salts, since we constantly find a blue oxide in salts of cobalt, a green oxide in those of nickel, a white oxide in those of bismuth, zinc, or lead, a grey oxide in those of silver, a yellow oxide in those of gold, and a brown oxide in those of platina. On the other hand only two white oxides of antimony unite with acids; so also it is only the grey and the white oxide of tin, or the black and the red oxides of quicksilver, or the yellowish white, and the brown oxide of copper, that are found in the salts of these metals.

It has been supposed by some, that in all the salts of iron the oxide was either green or red; some chemists have added to these a yellow oxide, because some salts of iron are of this colour. But it is probable that these yellow salts are formed of a red oxide. There exists, however, a white oxide of iron, as is easily shewn by pouring an alkali into a solution of iron made by the sulphuric acid. A white precipitate is formed, which, on exposure to air, becomes green at the surface, or even red: this oxide does not retain any sulphuric acid.

It is this white oxide, supersaturated with sulphuric acid, which forms the greater part of the green vitriol used in the arts. This oxide is sometimes united with a greater proportion of sulphuric acid; and as the green and red oxides also unite each with two different proportions of sulphuric acid, there are no less than six species of sulphate of iron. The author distinguishes them, partly by the colour of the oxide, and partly by the state of the acid by

the several names of acidulous, and acid, sulphate of white oxide of iron; acidulous, and acid, sulphate of green oxide of iron; and neutral, and acid, sulphate of red oxide of iron.

The acidulous sulphate of white oxide of iron is obtained by boiling diluted sulphuric acid upon iron: it is always of a bottle-green colour, and is the most esteemed in the arts. By the addition of sulphuric acid it changes to an emerald-green, and thus becomes acid sulphate of white oxide of iron, which has a more powerful action upon blue colours. When sulphuric acid is poured into a solution of acidulous sulphate of white oxide of iron evaporated to 36°, this acid sulphate of white oxide of iron is precipitated in white crystals. So it sometimes happens in manufactories of green vitriol, that, in the process of evaporation, the liquor deposits a white sediment, flung away by the manufacturers under the name of *magnesia*. This arises from the solution being surcharged with acid; so that at a particular period a division of it takes place, and the two sulphates of white oxide of iron are formed, of which that which is acid precipitates. This inconveniency may be avoided by boiling the solution on iron, and adding water if necessary. This process converts all the acid sulphates of iron, of whatever colour, into acidulous or neutral ones, and is practised in many manufactories, particularly at Beauvais, the sulphate there used having effloresced from turf. Both the sulphates of white oxide of iron are precipitated of a white colour by the alkalies. By the action of oxygenized muriatic acid they are changed into sulphates of green or red oxide of iron, in the same manner as the white oxide itself becomes green, or red, by the action of that acid, or of the air.

The acidulous and the acid sulphate of green oxide of iron are very different. The acidulous sulphate does not crystallize, and can only exist in a liquid form; for on evaporation it absorbs the oxygen of the air, and is decomposed, an acid sulphate of green oxide of iron remaining in solution, which is almost colourless, and the neutral sulphate of red oxide of iron being deposited. The acidulous sulphate of green oxide of iron is red, and may be procured by exposing the acidulous sulphate of white oxide of iron to the air. Oxygenized muriatic acid converts it at once into acid sulphate of red oxide of iron; on the other hand, iron changes it into acidulous sulphate of green oxide of iron. Sulphuric acid destroys its red colour, and changes it into the acid sulphate, which, although almost colourless, forms, on evaporation, crystals approaching to emerald-green, not effloresceing in the air. The solution of these crystals is very slightly coloured; it does not absorb oxygen, unless very slowly, the excess of acid which it contains fixing to a certain degree the oxide of iron; but by oxygenized muriatic acid, the oxide becomes red, and, by the addition of iron, it changes to the white oxide, especially at the temperature of boiling water. Both the acidulous and acid sulphates of

green oxide of iron are precipitated of a green colour by alkalies. This precipitate does not contain acid, if a sufficient quantity of alkali is used, and it is always of a green colour.

The acid sulphate of red oxide of iron is obtained by dissolving the red oxide in diluted sulphuric acid; for, if concentrated, the acid will not dissolve it. This acid sulphate contains a greater excess of acid than the acid sulphates of green oxide of iron; and this last contains more than the acid sulphate of white oxide of iron, agreeable to the general property of metallic oxides, which require more acid to saturate them as they are more oxygenized. Like the other two acid sulphates of iron, it is almost colourless: but it becomes red, when part of the excess of its acid is taken away, by potash. On adding more of the alkali, the neutral sulphate is precipitated, which may yet be decomposed by the alkalies: it decomposes, like all the salts of very much oxygenized iron, sulphuretted hydrogen passing itself into acid sulphate of green or white oxide of iron: it does not crystallize by evaporation; and iron changes it into a less oxygenized sulphate.

The solution of iron in gallic acid is at first colourless: by exposure to air it becomes blue; it then yields a deposit, and passes to a blackish grey. These phenomena arise from the three oxides that iron forms. Gallic acid being poured into the acidulous sulphate of white oxide of iron, does not produce a precipitate; poured into the acidulous, and the acid sulphate of green oxide of iron, it forms a fine blue precipitate; and when poured into an highly oxidized sulphate of iron, the precipitate is black, bordering on grey. An excess of acid prevents this precipitation. So the addition of an alkali to the acidulous sulphate of white oxide of iron is necessary to cause the gallate to be precipitated in violet flocks. The saturation of the acid, in the acid sulphate of red oxide of iron, is necessary to dispose it for precipitation by gallic acid: but the muriate of red oxide of iron, which is only slightly acid, does not require this previous addition.

The three oxides of iron form, with the prussic acid, a still greater number of compounds; for there exist not only neutral prussiates, and prussiates with excess of oxide, but both are capable of uniting with the prussiate of potash, and probably with the other alkaline prussiates. These triple salts are insoluble, if the metallic prussiate predominates; and soluble, if the alkaline prussiate is in superior quantity.

If the iron is slightly oxidized, the solution slightly acid, and the prussiate has an excess of alkali, a white precipitate is obtained; but if, while the other circumstances remain the same, the prussiate is neutral, the precipitate will be greenish-white.

The neutral sulphate of red oxide of iron is yellow, and insoluble in water. It is this salt that is precipitated from the acidulous sulphates of iron, either of the green, or of the white oxide, when exposed to the air. It is also precipitated from the acid sul-

phate of green oxide of iron by boiling; the solution then loses its red colour, because it becomes an acid sulphate. It is this salt which some chemists have taken for an oxide.

The muriates of iron are nearly similar to the sulphates; but the acid muriates are not so well characterized. The slightly oxidized muriate forms green crystals; but by exposing the solution to the air, the iron becomes more oxidized, and part of it precipitates.

There are no nitrates of white oxide of iron. The nitrate of green oxide of iron is formed by using acid of 5°; that of the red oxide, by using acid at more than 12° or 15°. If the acid is yet stronger, a portion of red oxide is precipitated; and at 30 to 40° a very small quantity remains in solution. This precipitation, as well as the little solubility of colcothar in nitric or sulphuric acid, is owing to the oxide not being sufficiently divided. Both these acids, however, dissolve the red oxide when recently precipitated from the nitrate or muriate by the alkalies.

The other acids have similar actions on iron; but as these combinations have little use in the arts at present, the author passes over them in silence, noticing only the gallates and prussiates of iron.

From the same cause, acids turn the prussiate of white oxide of iron, of a greenish colour; and on the other hand, alkalies change the prussiate of green oxide of iron to a white colour. These precipitates are not pure prussiates of iron, but contain prussiate of potash, which has such affinity for prussiate of iron, that even sulphuric acid does entirely decompose the insoluble combination of these two salts. When only a slight excess of acid is added, the residue still contains much potash, and is constantly green; it becomes bluish-green by a greater quantity, and, on analysis, is found to contain less alkali and oxide. When the alkaline prussiate is sufficiently abundant to render the combination soluble, the mutual attraction of these two salts is still more remarkable; for even sulphuric acid does not disengage the least quantity of prussic acid, and the sulphate of iron always causes a copious precipitation; although in pure alkaline prussiate the carbonic acid is capable of disengaging the prussic acid.

The same results are obtained by using the acidulous sulphate of green oxide of iron, and the muriate of red oxide of iron; which last is only slightly acid. The precipitates are always triple prussiates of iron and potash: that which contains the green oxide is less blue than that which contains the red oxide. Both change colour if united with a great excess of oxide; the first becomes yellowish-white, the second reddish-yellow; with a less excess of oxide, their colour is more upon a blue; but both may be rendered more lively by acids.

Hence there are six prussiates of iron, viz. three neutral, and three with excess of oxide; which excess may also be greater, or

less: and as all these may be combined with various proportions of the alkaline prussiates, the varieties of these salts are very numerous.

Prussian blue becomes green by exposure to the air, and thus forms an oxygenized prussiate of red oxide of iron. When common prussiate of potash is boiled with Prussian blue thus oxygenized, either totally or only in part, the oxygenized prussic acid unites with the potash, and the prussic acid is transferred to the iron; so that the filtrated liquor precipitates the nitrate or muriate of red oxide of iron, and of a green colour. This is the reason why some solutions of prussiates, made by means of Prussian blue, precipitate the slightly oxidized sulphate of iron, of a white colour, and not of a blue.

It is this variety of prussiates that renders their preparation so difficult. There still remain many improvements to be made in the manufacturing of Prussian blue, particularly the saving of the carbonate of ammonia, which is formed in the calcination; so that sal ammoniac might be made at the same time, which would increase the profit, with little addition to the expense. Equal quantities of potash and of blood are preferable to any other proportion; the addition of iron favours the formation of prussiate of iron, and fixes it; if the calcination is carried beyond what is necessary for the fusion of the mass, the prussiate of potash, or what is to form it, is decomposed at least in part. It is no less necessary to crystallize the prussiate of potash, in order to obtain Prussian blue of superior quality; for thus the sulphuretted hydrosulphuret of potash is changed into sulphate of potash; and it becomes also necessary to add but a small quantity of alum to saturate the excess of alkali: the sulphuretted hydrosulphuret of potash may also be decomposed by sulphuric acid, especially as that acid does not alter the prussiate of potash when united with a certain quantity of prussiate of iron. The crystallization is not, however, necessary in the preparation of common Prussian blue, in which a great deal of alum is employed, which could only be separated by a great quantity of potash; it will be sufficient to boil the liquor for some time to decompose the hydrosulphuret; and the sulphuretted hydrogen will be separated by the acid of the alum. Lastly, the operation would be much abridged by mixing with the prussiate of iron a small quantity of oxygenized muriate of lime, instead of washing it with a large quantity of water.

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*On the Oxidizement of Metals. By* J. M. Haussman.—*Ann. de Chim.* No. 166, *Tome* 56.

This letter to Berthollet is a continuation of the dispute, whether in the oxidizement of metals there are any intermediate terms between the maximum and minimum of oxidizement.

M. Haussman cites a number of experiments and observations which, he thinks, tend to prove the existence of these intermediate terms.

Muriate of tin not diluted with water being mixed with a concentrated solution of pure potash, much heat was disengaged, a part of the tin was precipitated in the metallic state, the other part remained in solution. This alkaline solution changes the yellow colour of gold fixed upon cotton by means of ammonia into grey, although pure potash had not this effect. The same change was produced by plunging into it cotton moistened with a solution of gold and then dried. Even a solution of gold much diluted, poured into the alkaline solution of tin, underwent a similar change. This liquor also discharges the blackish brown colour of the oxide of manganese fixed upon cotton by an alkaline precipitate.

All these changes are more rapidly produced, if the muriate of tin is diluted with six or eight times as much water before the potash is added; no heat is then disengaged, nor no tin precipitated in a metallic state. The solution does not lose its properties by exposure to the air.

Cotton dipped into the sulphate of manganese preserves its whiteness in drying; but on dipping it into a solution of pure potash, or carbonate of potash, and exposing it to the air, it becomes brown, which grows darker, and passes nearly into a black by being left for some time in an oxygenized alkaline muriatic liquor.

An oxygenized muriatic alkaline liquor takes a purple colour by standing for some time over the brown precipitate of manganese. The white oxide of lead becomes coloured, by being long exposed to the oxygenized muriate, and frequently stirred.

The muriate and the nitro-muriate of tin being much diluted are, when pure, of a watery transparency; but on being mixed, they take the colour of white wine. If into this mixture a solution of gold, with excess of acid and very dilute, be poured, the liquor takes a very fine purple tinge, and may be used in dying. Shades of peach and lilac colour will be produced if the nitro-muriate of tin predominates, and shades of grey if the muriate of tin predominates; but if this last is too abundant, the oxide of gold will be precipitated, which cannot be used for gilding by the rag. If this purple liquor is exposed to a strong heat, the purple powder of Cassius is precipitated.

The water-green acetous solution of iron takes a reddish-yellow tinge by exposure to atmospheric air or oxygen. By mixing sulphuric acid with nitrate of iron, evaporating the nitric acid, and exposing the residuum to the humidity of the air, fine white crystals of super-oxygenized sulphate of iron are obtained, which grow yellow by exposure to light; but a slight washing restores their whiteness. The same kind of crystals may be obtained

by precipitating nitrate of iron, and dissolving the precipitate in sulphuric acid.

Linens printed with acetate of iron and maddered, are a long time in bleaching; and the printed part is frequently so much injured that the place appears to be burnt, or corroded by a strong acid.

Any solution of indigo (except the sulphate) passes through every shade of bluish-green, even to that of a very yellow olive, and yet retains the same quantity of indigo of solution. Indeed the beauty and solidity of the blues, whether for the bath, or for pencil-work, depends upon the degree of oxidizement.

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*Further Observations on some Memoirs by Proust. By* C. L. Berthollet.—*Jour. de Phys. Brum.* xiv. *Tome* 61.

Proust, it is well known, admits only two degrees of oxidizement in metallic substances; but yet imagines it probable that the two extremes may unite together, and that the combination ad minimum may also dissolve the simple substance. Against this opinion the present paper is directed, and it is to be followed by another on the solutions of metals.

Tin melted in contact with air becomes covered with a blackish pellicle, but without any appearance of inflammation. This is the first degree of oxidizement. The oxide may be separated from the metallic grains which adhere to it by repeated triturations and elutriations. Muriatic acid poured on this oxide dissolves part of it, and disengages hydrogen; the undissolved portion becomes of a whitish colour.

The former oxide, on being exposed in a test to a fire, which causes the bottom of the vessel to become of a very slight red, is covered with a very vivid light; if the test is then taken from the fire, and the oxide stirred, so that every part of it may be rendered luminous, the oxide, when the light has disappeared, will appear of a light grey colour. A farther exposure to the same degree of heat does not reproduce this species of inflammation This oxide does not disengage hydrogen when treated with muriatic acid.

If the heat be raised, the oxide again becomes luminous, but less so than before. The third oxide thus produced is of a lighter grey.

By a still stronger heat, the third oxide again becomes luminous, although the light is inferior to that of the last operation. The oxide is of a still lighter shade of grey.

The fourth oxide thus produced, being again urged by a stronger heat, becomes lighter, or of a white with a shade of ash-colour. This fifth oxide was not reducible by being treated with

resin, oil, or charcoal; but it was reduced by means of the carbonized residuum of tartar.

Tin exposed at once to a great degree of heat yields a vivid light, and is changed to a white oxide. This sixth kind of oxide may also be obtained by detonating tin with nitre. The same white oxide may also be obtained by means of the oxymuriate of potash.

Tin reduced to an oxide by means of nitric acid, and then exposed to heat, becomes yellow: so that if the opinion of Proust be adopted, that the yellow oxide is the oxide ad maximum, we might distinguish seven degrees of oxidizement in tin; but even avoiding every cause of illusion, we must necessarily admit five.

Chemists already admit four degrees of oxidizement in lead: but M. Berthollet thinks it necessary to state the particulars of their formation to shew the difficulties in Proust's theory.

Lead, by a slight calcination, yields an oxide, which may be separated, although less easily than that of tin, from the unoxidized metal. This oxide is grey, with a shade of yellow; and it evidently appears that it has undergone some alteration in the elutriation, which, without doubt, was occasioned by the oxygen in the water.

This oxide, exposed to a brisk heat, inflames, but with much less vividness than the oxide of tin, and becomes yellow of different shades according to circumstances.

The yellow oxide is changed by a slow calcination into red lead, which however contains both carbonic acid and azote; but on being slightly heated these are disengaged, and a pure red oxide is left. The red oxide, by exposure to a considerable degree of heat, gives out oxygen, and reverts to the state of yellow oxide, or to litharge if the heat has been violent.

The red oxide, treated with nitric acid, or with oxygenized muriatic acid, absorbs more oxygen, and is changed into a flea-brown oxide.

It will not be possible to reconcile these various changes to Proust's hypothesis without several inconsistencies. It is equally probable that there are more than two terms of oxidizement in iron. Sulphate of iron, which has been formed with an excess of iron, or which has been kept for some time upon iron-filings, yields, with alkalies, a white precipitate. Sulphate of iron that is rather more oxidized yields a blackish precipitate: and this last sulphate does not contain the red oxide of iron, and the oxide ad minimum, for ammonia dropped gradually into the solution causes an uniform black precipitate; but this alkali, according to Gay Lussac, precipitates the red oxide in preference to any other when they occur together.

The nature and number of the oxides of iron is best known from the consideration of the native oxides joined to that of the artificial kinds. Bournon has observed, that there are several natural

oxides of iron. The first and least oxidized is the fer oxidulé of Hauy, which is strongly attracted by the magnet, and crystallizes in regular octahedrons. The second is the fer oligiste of Hauy, which is less magnetic, and crystallizes in rhomboids slightly acuminated. The third stage, according to Hauy, is denominated by him fer oxidé: this is no longer attracted by the magnet, and is not crystallized. The Count himself inserts between the fer oligiste and the fer oxidé of Hauy, a fourth species with a grey colour, and a specular aspect, which is not magnetic, but crystallizes in perfect cubes. Its powder is redder than that of the fer oligiste of Hauy, but it has the yellow shade observed in the powder of hæmatites.

Daubisson is for increasing the number of native oxides still further, and thinks that there are at least seven distinct species.

1. Very magnetic black fer oxidulé.—Hauy, iv. 10.
2. Grey magnetic ore, with a dark red trace, from Sweden. —Hauy, iv. 47.
3. Specular iron ore, of volcanoes, formerly called by Hauy fer pyroceté.—Hauy, iv. 47, & seq.
4. Grey iron ore of the island of Elba.—Hauy, iv. 45.
5. Iron ore from Frammacont, in grey lamellar crystals, but with a shade of red.—Hauy, iv. 46.
6. Micaceous iron ore, or the eisen glimmer of the Germans. —Hauy, iv. 45.
7. Rother eisenrahm, or the red scaly iron ore.—Hauy, iv. 106.

To which may perhaps be added, as an eighth kind, the common red oxide; but besides these principal terms, there are an hundred others which an experienced eye can distinguish.

All the minerals of these different terms are homogeneous in the eyes of mineralogists; they have each a peculiar crystalline form, and they yield nothing on analysis but iron and oxygen; and it is probable that the oxygen is uniformly diffused through them.

M. Berthollet only controverts the union of oxygen with bodies in no more than two proportions; but it must not be imagined that he supports the idea that every degree of oxidizement between the maximum and the minimum is equally possible, as he has positively asserted the contrary in his Essai de Stat. Chim. §§ 371, 387, 388.

Proust allows that the oxides are less volatile than the metals from whence they are formed, and instances those of tellurium and of copper; and he thinks that of the four oxides, formerly mentioned by M. Berthollet, two of them ought to be considered as exceptions to the general rule, viz. the oxide of antimony and that of arsenic; he even considers antimony as being absolutely fixed, but says, that the two oxides of this metal rise in vapours, and line the upper part of the vessels with their long silvery threads.

Metallic antimony exposed in a retort to a violent heat, yielded

a considerable quantity of white transparent threads, which sublimed into the neck of the vessel, and along with these several mamillary lumps, which retained their metallic properties. The oxide thus obtained was exposed in a still more violent heat, in a crucible covered with another crucible; only a small quantity of white pulverulent oxide was sublimed; the far greater part remained at the bottom, and formed a yellowish glass, slightly transparent.

Another portion of the oxide exposed again in a retort, to a heat that was at least equal to that by which the oxide had been formed, yielded only a small portion of sublimed oxide, in the form of needles; the remainder formed a hard mass: hence we may justly conclude, that the oxide of antimony is more fixed than the metal

In the same manner tin is volatilized, when it is exposed to a violent heat, or when it is detonated with nitre, or with the oxygenized muriate of potash, and is changed into a white oxide, which is no longer volatile. Geoffroy has noticed that tin, exposed upon charcoal to the focus of a lens, dissipates in smoke; but that when it was placed upon a cupel, it became oxidized, and remained a long time. The oxide of tin heaped up in a cupel did not melt in the focus, but only became soft and smoked; the heap fell down, and formed groups of fine crystals, rough, brittle, and transparent, which were scarcely altered by a further continuance in the focus.

Bismuth also and lead, when exposed to violent heat, are sublimed in the form of oxides, which, when re-exposed to a more violent heat, remain fixed.

Arsenic cannot be esteemed an exception to the general rule, since Bergmann, Wasserberg, and Beaume, all agree that the oxide is less volatile that the metal itself.

The black appearance which the red oxide of iron assumes when strongly heated, led M. B. to suppose that it lost some of its oxygen; but on heating the oxide in a porcelain retort, no oxygen was obtained, although the oxide became brown. Exposed to the most violent heat of a forge, it turned black, and appeared like the oxide which is formed by the decomposition of water; but when reduced to a very fine powder, it was found to be only a very deep red. The powder boiled in muriatic acid did not produce any oxygenized muriatic acid, and yet ammonia precipitated from the solution the red oxide. These changes of colour are apt to deceive, but M. B. does not conceive how Proust can say, that the oxide of lead melts without changing its state.

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*Observations.*—In this long pending dispute which does not seem to be yet ended, it evidently appears that Berthollet and his supporters have considerably the advantage. Much of the strength of his adversaries is spent in combating a phantom, conjured up by themselves, viz. that in Berthollet's opinion every possible de-

gree of oxidizement exists; but Berthollet himself positively denies that he holds this opinion, as he has allowed, in his Statique Chimique, that the oxide in every metallic salt has a determinate degree of oxidizement.

The hypothesis of Proust, that there exist only two terms of oxidizement, *i. e.* the maximum and the minimum, and that all the other oxides are either combinations of these terms with one another, or of the oxide ad minimum with the unoxidized metal, is merely a modern variation of an old metaphysical dispute, as to the mixtion of bodies in different proportions, which has always occupied the minds of speculative naturalists. Chemists ought to reject such idle subtleties, and rest satisfied with determining the proportions of the constituent ingredients in each oxide, as far as they can be ascertained by our limited powers.

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*Experiments made by the Galvanic Society on the Composition of muriatic Acid; reported by Mr. Riffault.—Ann. de Chim.* No. 167, *Tome* 56.

The Society, in making these experiments, had no other guide than a letter addressed by Prof. Pacchiani to M. Pignotti; in which however he did not explain the apparatus he used, but simply stated that he had employed the galvanic pile. They therefore determined to employ the same agent, and to use what they conceived to be the most likely means of applying it.

A tube 0,081 metre in length, and 0,009 metre in diameter, with a crooked capillary tube at one end, was filled with distilled water, which had no effect on nitrate of silver. By means of two wires of pure gold, communicating with a pile of 52 pair of plates, rendered active by a solution of muriate of soda, the water was continually exposed to the galvanic influence for 34 days; during which time it was observed, that the activity of the pile was always much stronger from noon to 4 o'clock, after which it declined.

At the end of this process the water in the tube was diminished one half, but had lost nothing of its limpidity. The extremities of the gold wires were corroded, and particularly that wire which communicated with the zinc end of the pile: 793 cubic centimetres of gas were obtained. The remaining water had no taste, nor no action on the tinctures of turnsol, nor of Brazil wood, and did not in the smallest degree affect nitrate of silver. The gas being examined, both by the eudiometer of Fontana, and by that of Volta, shewed 30 per cent. of oxygen.

In another experiment, 2 grammes of distilled water were included in a glass inverted syphon; and by means of two ordinary gold (*i. e.* silver gilt) wires, the water was exposed to the action of a pile of 50 double plates, separated by sand, moistened with

river water acidulated with $\frac{1}{60}$ of nitric acid. During the very first day the water next the copper end of the pile acquired a reddish brown tint, and the wire was covered with a deep brown oxide of gold; the wire connected with the zinc end of the pile did not acquire the same colour, the gold was dissolved and precipitated, as also a part of the silver. This precipitate, on examination with a lens, exhibited needle-like crystals, along almost the whole length of the tube. The wire lost all the gold that covered it, and was reduced to an extremely fine wire of silver. Very little gas was disengaged during the process of the experiment, which lasted from 28 Messidor to 8 Fructidor; and the water had not lost $\frac{1}{50}$ of its volume. The water that remained had not any trace of acidity, but only a metallic taste.

Hence the Society conclude, that the only effect of the galvanic pile, when applied in this manner to water, is to decompose a part of it, and to separate, in a state of purity, the oxygen and hydrogen of which it is formed. They also imagine that Prof. Pacchiani was either deceived as to the acid he imagined himself to have formed, or that it came from some animal or vegetable matter which he had used in his apparatus.

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*On the Composition of muriatic Acid. By Dr.* F. Pacchiani.—*Ann. de Chim.* No. 167, *Tome* 56.

Dr. Pacchiani finds great fault, in this letter to M. Fabroni, with the persons who have attempted to repeat his experiments on the formation of oxygenized muriatic acid from water, by the action of the galvanic fluid, because they have used two wires, one communicating with each end of the pile. For, as is well known, oxygen and hydrogen are separated at the same time, and in the same proportion in which they existed in the water employed, and therefore no oxygenizement or hydrogenizement of the remaining liquid could possibly take place, as has been observed by Humboldt and Gay Lussac.

He therefore explains in this letter his apparatus for the separation of oxygen or hydrogen only, from water.

The apparatus for the separation of oxygen only from water, and for the consequent hydrogenizement of that liquid, is a tube with two orifices, one small with the edge not turned over, through which is to be introduced a gold wire, and the orifice then closed up with sealing-wax. The tube is afterwards to be filled with water by the other orifice, and having closed this orifice with fine white linen cloth twisted up, plunge the tube by this end into a vessel of water, which by means of strips of moistened paper communicates with the negative end of a galvanic pile. On connecting the gold wire with the positive end, the water will gra-

dually lose its oxygen, and be changed into oxygenized muriatic acid.

The same apparatus serves for the separation of hydrogen from water, and the consequent oxygenizement of that fluid; merely, by reversing the galvanic communication, so that the metallic wire may communicate with the negative end of the pile, and the water in which the tube is placed with the positive.

Dr. Paccliiani imagines that this oxygenized water might be a convenient method of introducing oxygen into the human body, for medical purposes.

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*On the Production of muriatic Salts by the galvanic and electric Decomposition of Water. By* William Peel.—*Phil. Mag.* No. 91.

The following experiments were undertaken with two views, viz. 1. To determine whether the difference in his former experiments (related in our first volume, p. 182) was owing in any degree to his having employed lime to neutralize the water employed, in the second experiment, before it was distilled. 2. To ascertain whether the salts found in the residual water, or any component part of them, came from the galvanic battery by means of the wires.

Water containing lime was distilled, and then partly decomposed; the residual water yielded muriate of potash.

Water containing magnesia was distilled, and then partly decomposed; the residual water yielded muriate of soda.

Snow water was twice distilled, and then partly decomposed; the residual water yielded muriate of soda.

Water distilled from barytes was also employed; the residual water yielded muriate of soda.

The pump water employed by Mr. Peel in his former experiment, in which muriate of soda had been formed, was examined, but not the minutest portion of magnesia could be detected in it. From this examination, and the three last experiments, he concludes that the production of soda has nothing to do with the presence of magnesia, but that the presence of lime is essential to the production of potash. On this latter subject he is engaged in making fresh experiments.

The use of an electrical machine gave the same result as arose from the use of a galvanic battery.

*On the Probability that muriatic Acid is composed of Oxygen and Hydrogen. By* J. MARTIN.—*Phil. Journ.* No. 52.

THE hydrogen, which is disengaged on dissolving tin in muriatic acid, has been accounted for, by supposing that the water combined with the muriatic acid is decomposed; but the hydrogen gas might also arise from the decomposition of the acid, the oxygen of which united with the metal, and rendered it soluble: on this hypothesis no decomposition of the water is necessary.

A current of muriatic acid gas, disengaged by means of concentrated sulphuric acid from muriate of soda carefully freed from its water of crystallization, was made to pass over iron wire ignited in an earthen tube; hydrogen gas, in quantities too considerable to arise from any moisture contained in the gas, was disengaged, and crystals of muriate of iron were left in the tube. A small quantity of muriatic acid gas passed at the same time with the hydrogen.

*Observations.*—Ever since the origin of the French sect in chemistry, it has been an object of great importance among its adherents to analyse the muriatic acid, and to separate the unknown substance which, according to their preconceived opinion, is united with oxygen so as to form this acid. This hypothetical basis has, by some of these chemists, been guessed, from certain phenomena, to be hydrogen, and by others to be zinc.

We have already made some observations upon the subject, in our first volume, page 181; and therefore we shall only observe upon the papers now before us, that, as it appears from Prof. Pacchiani's relation of the processes he employed, the communication was formed by a metallic wire to one pole of the pile, and by linen and paper to the other pole, there still remains some doubt whether the muriatic acid obtained was not produced from the elements of the linen. This doubt can only be cleared up by the repetition of the experiment in different manners.

The experiments reported by Riffault were not likely to succeed, for the reasons mentioned by Pacchiani. Indeed it seems to be necessary to the success of this experiment, that either there must be some difference in the conducting power of the substances by which the current of galvanic or electric fluid is passed through the water, or that some very attractable base must be present in the water, which may arrest the nascent acid, and retain it for examination.

*Experiments on Tannin and on gallic Acid.* By BOUILLON LAGRANGE.—*Ann. de Chim.* No. 167, *Tome* 56.

THE author thought that, notwithstanding the researches of Seguin, Proust, Davy, Berthollet, and Vauquelin, there still remained much to be done, and therefore proposed to himself the following questions:

Does the substance called tannin exist in a state of purity?

Is this substance the same in all the vegetables that contain it?

Does it exist in all astringent and bitter vegetables?

If pure tannin can be obtained, are its combinations to be considered as saline?

Is tannin the radical of the gallic acid?

Is the gallic acid formed in Scheele's process for obtaining it?

The present memoir is only the beginning of his researches on these subjects; and he means to give in a future paper an analysis of the gallic acid, and a comparison of the acids obtained in the processes of Scheele and Deyeux.

Nutgalls by infusion in water without heat, or by the help of decoction, yield very different products. The decoction on cooling lets fall a considerable quantity of a thick elastic substance, of a dirty grey, which becomes darker by exposure to the air. This substance, when it is rubbed with lime or pure potash, disengages ammonia. It melts by a slight heat: cold water dissolves but little of it, hot water dissolves a much greater quantity of it, but the liquor always becomes turbid on cooling: the solution reddens the tincture of turnsol.

Nutgalls infused without heat do not yield this precipitate; all the tannin remains in the infusion, which is clear, and in the first infusions is of a deep-brown colour; but the last infusion scarcely yields any colour to the water. These infusions must be repeated 18 or 20 times; all these infusions redden tincture of turnsol. M. Lagrange has never been able to exhaust nutgalls entirely of their gallic acid, nor to obtain, in the latter infusions, tannin unaccompanied with that acid, as Berthollet had advanced.

The mineral acids, and several vegetable ones, exhibited the same phenomena as have been described by Deyeux, Dizé, and Proust: the tannin obtained by these processes is never pure, but it contains less colouring extract than what is obtained by other processes.

After a long boiling of pure alumine, recently precipitated by ammonia, with the infusion of nutgalls, the earth acquired a yellow tinge. The liquor being filtered, and a solution of glue poured into it, a precipitation took place, which shewed that it still contained some tannin. The alumine thus coloured yellow

was carefully washed, and then boiled in water acidulated with muriatic acid; it was speedily dissolved, and on cooling, a brown substance was separated, which by drying became brittle. It had an astringent taste; it did not attract moisture; it was soluble in water. Sulphate of iron produced a black precipitate with this liquor, which then became clear and limpid: more lime-water being then added, another precipitate of a blue colour fell down, owing to the gallic acid that the liquid still retained; but this blue colour is not always to be attributed to gallic acid, for a greenish blue may be obtained by means of tannin, according to its degree of oxygenizement. The liquor did not contain muriatic acid, as the precipitate obtained by means of nitrate of silver was dissolved in nitric acid. Hence M. Friedler's process for obtaining gallic acid is defective, because the alumine is always combined with that acid, and the liquor that M. Friedler affirms to contain only the gallic acid, contains also a quantity of tannin.

When lime-water is added to the infusion of nutgalls, a precipitate falls down, which is immediately redissolved. This solution takes place as long as the liquor shews an excess of acid. When a quantity of lime-water is added, and a white precipitate is produced, it is a tannate of lime that falls down, which is not oxidized, or at least but very little, for as fast as it absorbs oxygen, it becomes green.

A still greater quantity of lime-water produces a blue precipitate; the supernatant liquor is no longer precipitated by the solution of glue, but it acquires a fine blue colour with sulphate of iron.

If more lime-water be still added, the precipitate is of a very fine blue, which becomes green when the liquor is heated. And lastly, a fresh addition of lime-water partly redissolves this precipitate, there remaining only some reddish flocks.

The blue and white precipitates were washed and dried; the white precipitate became of a greenish grey; it was tasteless; it did not melt by heat; it was not soluble in water, but it dissolves very easily in weak muriatic acid. The solution, although it was acid, had an astringent taste, it became black with sulphate of iron, and was precipitated by solution of glue. A precipitate was also formed in this liquor by lime-water and oxalate of ammonia.

The blue precipitate acquired by the drying a blackish shade; it was tasteless, partly soluble in boiling water, which changed its colour to a deep yellow. The sulphate of iron precipitated the solution of a black colour, but a solution of glue did not produce any change.

Hence it appears, that the first precipitate is tannate of lime, mixed with a little gallic acid, or gallate of lime; and that the second precipitate is a gallate of lime, mixed with a little extract.

Different products may be obtained, by varying the process. Thus, if only a sufficient quantity of lime-water be added to the

infusion of nutgalls, to cause the precipitation of the white powder, the tannate of lime may be procured without any mixture of gallic acid. The necessary quantity is however very difficult to be ascertained; at any rate we must be certain that the remaining liquor will give more white precipitate without any shade of blue.

If more lime-water is added to the liquor, separated from the former precipitate, until it becomes of a fine blue colour, a precipitate of tannate and gallate of lime is obtained. After this the liquor yields, by the addition of more lime-water, only gallate of lime. The author speaks highly in favour of this separation of the several precipitates formed in each stage of a process, and is of opinion that many combinations, which are obtained in analysing substances, are not what they are supposed to be; and that these combinations may be greatly varied by this means: he intends to publish some observations on this subject.

M. Lagrange has observed the phenomena described by Deyeux, to arise from the action of the pure or carbonated alkalies on the infusion of nutgalls, and found his observations to be just. Proust has supposed that the alkaline carbonates, and some very soluble neutral salts, precipitate tannin from the infusion of nutgalls, by reason of their attraction for water being superior to the attraction between tannin and that fluid. But M. Lagrange is of opinion, that in regard to the carbonate of potash, the precipitate arises from the basis of that salt combining with the gallic acid which kept the tannin dissolved; in consequence of this abstraction that substance is, he thinks, precipitated.

As to the neutral salts, M. Lagrange has found that acetate of potash produces, with infusion of nutgalls, a flocculent precipitate, which had more colour than that produced by the carbonates, and was more soluble. It soon concreted into a mass, so that the tannin appeared to retain some of the acetate. Neither dried crystals of muriate of lime nor their solution produced any precipitate, when used in a small proportion; but by increasing the quantity, a grumous substance was separated, less divided and less white than the precipitate by the carbonates, and in very small quantity. The precipitate by the muriate of ammonia is much more abundant. Lastly, a very strong solution of sulphate of potash produces a very abundant precipitation in the infusion, but a solution of soda does not produce any change in it. On the whole, therefore, Proust's opinion, in respect to neutral salts, appears to be unfounded.

The process of Proust for obtaining tannin, by means of the carbonate of potash, is defective, because the tannin retains some of the potash; so also the excess of nitric acid in the process of Mérat not only occasions the quantity of tannin which is separated to be very small, but it is also contaminated with lime and extractive matter.

The best process, according to M. Lagrange, is to pour into the infusion of nutgalls, made without heat, a solution of the crystals of neutral carbonate of ammonia, and to agitate the liquor in order to facilitate the disengagement of the carbonic acid gas: the carbonate is to be added until the liquor no longer becomes turbid. The precipitate is to be washed with cold water, but without the access of air, until it comes off colourless. The washed precipitate is then to be washed with alcohol at 40°, until the alcohol no longer reddens tincture of turnsol: the first parcels of alcohol yield a very fine blue precipitate with lime-water, but the last parcels yield only a flocculent precipitate, without any shade of blue. The precipitate after these repeated washings is not to be dried by heat, but merely deprived of its moisture by blotting-paper.

The tannin thus prepared is white, of a very austere and bitter taste; it does not redden tincture of turnsol. Exposed to the sun, its surface, if fresh prepared, turns black; but when it is dry, it only becomes slightly brown. On being exposed for some time to the air, it alters in respect to its solubility, and it changes the colour of turnsol. Also if oxygen is passed through water, in which tannin is kept suspended, the liquor will redden tincture of turnsol.

By heat tannin does not melt, but dries and softens; the charcoal of it is easily incinerated; the ashes are white, not alterable by the air, composed of sulphate of potash, carbonate of lime, and a very small quantity of carbonate of potash.

The tannin thus procured is different from that described by Proust; as he says that his tannin softened in the hand, especially when moist, that it melted very easily, and left on burning a bulky charcoal, difficult to be reduced to ashes, which were white, but became green by exposure to the air. The solution of these ashes in water rendered turmeric paper brown; the acid of tartar, added in excess to this solution, yielded an abundant precipitate of acidulous tartrite of potash; but M. Lagrange has not been able to obtain this salt from the ashes of tannin prepared by his process.

M. Lagrange has observed all the phenomena described by Proust, as taking place on exposing tannin to heat in close vessels, except that he found some gallic acid was sublimed into the neck of the retort.

Cold water has only a slight action on tannin, hot water has much more, but the solution grows turbid on cooling.

Caustic alkalies ground with tannin render it brown; it grows liquid, and ammonia is disengaged.

Concentrated sulphuric acid dissolves, and carbonizes it, disengaging sulphureous acid; if dilute, it is not entirely dissolved in the cold.

A small quantity of very weak nitric acid softens tannin, and

slowly dissolves it. Neither sulphate of iron nor solution of glue forms any precipitate in this solution, but lime-water changes it to a rose colour. When heated it yields nitrous gas and carbonic acid gas; the residuum yields oxalic acid, and the tannin is entirely destroyed.

Muriatic acid did not dissolve tannin in the cold; but by heat, a substance was obtained which is elastic whilst it is warm, but becomes hard and brittle on cooling.

Concentrated oxygenized muriatic acid took away the smell of fresh tannin; the liquor being decanted, yielded a slight precipitate with solution of glue. Fresh portions of acid were added till the tannin was totally dissolved, observing to employ no more acid than was necessary. These solutions being added together were evaporated to about one half. Sulphate of iron poured into part of this evaporated liquor, produced a beautiful blue colour, which was not changed by being left to rest. The other part of this liquor was gently evaporated almost to dryness; it had then no longer an austere taste, and on distillation yielded not only pure muriatic acid, but gallic acid was also sublimed into the neck of the retort.

Alumine boiled in a concentrated solution of tannin became coloured; the compound was tasteless, insoluble in water; weak muriatic acid dissolved it by the help of heat, but on cooling, tannin was precipitated.

Lime-water poured into a solution of tannin, yielded a weighty precipitate of deep green, which became paler by drying.

Warm acetous acid dissolved tannin, which precipitated on cooling in brown flocks; but some of it was retained by the liquor, notwithstanding the excess of acid.

Very weak muriatic acid gave the same result.

Tannin rubbed with lime-water did not combine with all the lime; by heat, light flocks were precipitated of a brown-yellow, which became deeper by exposure to air.

Barytes water mixed with a concentrated solution of tannin, yielded very heavy greenish flocks, which became of a deep-brown when dried; the supernatant liquor was of a clear green, and did not contain any barytes: the precipitate was insoluble in water.

Strontian also unites with tannin into a mass, which is of a clear green when it is fresh, and becomes grey on drying: it is insoluble in water.

Tannin, added to a weak solution of potash to saturation, renders it coloured; the solution is not precipitated by glue, but the sulphate of iron produces a dirty, bluish, heavy precipitate. The solution being evaporated to dryness, left a brownish brilliant substance, which did not become moist in the air, and on being strongly heated in a crucible for a long time, the tannin was with difficulty decomposed; the potash only was left.

Soda produced the same effects.

Ammonia cannot be combined with tannin to saturation, and may be separated by heat from it.

Carbonate of potash, as well as carbonate of soda, favour the solution of tannin in water, and combine with it, without any effervescence.

In some combinations of tannin with metallic oxides, it becomes oxidized, and acquires new properties.

By long boiling, the tannin may be saturated with oxide of iron, or with the red oxide, which forms a blackish-brown combination.

Red oxide of lead boiled with tannin produces a deep brown substance, and the liquor does not retain any tannin. Sulphuric acid added to this tannate, forms an insoluble sulphate, while the liquor retains the oxidized tannin.

Red oxide of quicksilver, united with tannin, is also deep brown; part of the oxide is reduced.

Metallic salts are decomposed by tannin.

A concentrated solution of tannin, poured while warm into a solution of acetate of lead, disengaged a strong odour of acetous acid, and formed a white-grey, heavy precipitate. The supernatant liquor retains acetate of lead, with excess of acid; but on adding an excess of tannin to acetate of lead, the liquor did not retain any of the acetate; the precipitate, when well washed, was greenish, which soon became brown on exposure to air. Dilute sulphuric acid decomposed this tannate, and the liquor retained tannin in solution. Weak nitric acid, when heated, also dissolved this tannate, and the solution lets fall tannin on cooling; but some is retained in solution, for both glue and sulphate of iron form a precipitate in the liquor.

The salts of copper are not entirely decomposed by any quantity of tannin, and the saline liquor, although boiled, retains some portion of it. The precipitate settles quickly, and when under the liquor, is of a lead brown, but it becomes darker by drying. The strong acid decomposes this tannate.

Sulphate of manganese is decomposed by tannin, and forms a clear green precipitate, which changes to brown, by heat or exposure to the air.

The neutral nitrate of quicksilver is decomposed by tannin, and produces a very clear yellow tannate.

Nitrate of silver, very much diluted, is not apparently decomposed; but when both the solutions are concentrated, a reddish-brown precipitate is formed.

Tannate of iron is deep blue when fresh, and of a beautiful black when dry; the attraction of tannin for iron yields only to that for lead; and the decomposition of sulphate of iron may be rendered so complete, that neither tannin nor iron shall be retained in the supernatant liquid. Tannate of iron is insoluble in

water; it is soluble in muriatic acid, and barytes added to this solution, does not cause any precipitation.

As Davy has shewn that catechu, vulgarly called Japan earth, contains the greatest quantity of tannin of any known substance, it was important to make some particular observations on it.

Catechu dissolves in water; the solution is of a very deep red, which slightly reddens turnsol paper. The neutral alkaline carbonates and some neutral sulphates scarcely render this solution turbid; muriate of ammonia and muriate of barytes form a sensible precipitation in it. The precipitate, by the solution of glue, is less in quantity, but more coloured than with infusion of nutgalls; the supernatant liquor retains its bitter taste, and even yields a precipitate with sulphate of iron. Catechu triturated with potash, disengages ammonia.

Alcohol separates a gummy substance from catechu; the solution reddens tincture of turnsol, and turns green with sulphate of iron. When this tincture is evaporated, it becomes a brilliant substance, like a varnish, scaling off in transparent fragments, and does not alter by the air.

Catechu puffs up by heat, melts, and becomes carbonized. Its ashes are white and light; they contain sulphate of lime, muriate of potash, carbonate of lime, oxide of iron, and a little silica. By distillation, it yields an acid liquor, acetate of ammonia yielding a fine deep blue with sulphate of iron.

Nitric acid at 36° acts strongly on catechu, and disengages nitrous gas; the solution contains oxalic acid tinged yellow, and very bitter. On dissolving these crystals in water, there remains a substance insoluble in water or alcohol. When nitric acid at 18° was used, the same substance was obtained, and it appears to be similar to the detonating substance obtained by Fourcroy and Vauquelin, from indigo and other substances containing azote.

Hence catechu appears to be composed of tannin, extractive matter, mucilage, gallic acid, azote, and some earthy salts. And M. Lagrange thinks that it not only contains less tannin than nutgalls, but that the tannin is somewhat oxidized; the gallic acid in it also differs from that of nutgalls, as it never produces a blue colour with sulphate of iron, but always a green. The extractive matter cannot be separated from the tannin, on account of their great attraction for one another.

The author also thinks that there is only one species of tannin, which undergoes various alterations according to the process used for its extraction, on account of the facility with which it unites with other substances. Even the contact of the air is sufficient to alter it.

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*Observations.*—The subsequent observations of Hatchett upon the artificial production of tannin, by which it can be procured in a purer state than from vegetables, where it mixed more or

less with extractive and other extraneous matter, have rendered the operose processes of those chemists antiquated, who, led by the fashion of the day, began at the wrong end, and attempted to purify the native tannin, instead of inquiring whether it could not be procured by oxygenizing some of those substances which might be procured in a pure state.

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*On an artificial Substance, which possesses the principal characteristic Properties of Tannin. By Mr.* CHARLES HATCHETT.—*Phil. Trans. for* 1805, Part II.

THE only fact hitherto known of the production of tannin was an observation of Chenevix, that a decoction of coffee-berries did not precipitate gelatine, unless they had been previously roasted; but Mr. H. has found that an artificial tanning substance may be formed by very simple means.

By long digestion of the resins with nitric acid, they are dissolved; and by evaporation a deep yellow viscid substance is obtained, which is equally soluble in water and in alcohol; but with the bitumens, as asphaltum, or jet, nitric acid formed a very dark brown solution, and a deep yellow or orange-coloured mass was separated, which, treated as the resins were, afforded a similar product, except that it emitted, when burning, an odour somewhat resembling that of the fat oils.

The dark-brown solution was conceived by Mr. H. to be a solution of the carbonaceous part of the bitumens. He therefore digested asphaltum, jet, several of the pitcoals, and charcoal, in nitric acid, and separated the yellow mass from those solutions in which it appeared: the charcoal was dissolved the most readily, and its solution, which was reddish-brown, did not leave any residuum. When these solutions were evaporated to dryness, brown glossy residua were left, which exhibited a resinous fracture.

These residua were soluble in cold water, and in alcohol: their flavour was highly astringent. Exposed to heat, they smoked a little, swelled much, and afforded a bulky coal. The aqueous solution reddened litmus paper: they copiously precipitated some metallic salts, especially muriate of tin, acetite of lead, and oxysulphate of iron; these precipitates were commonly brown, inclining to that of chocolate; that of tin was blackish grey. They precipitated gold from its solution, in the metallic state: they also precipitated some earthy salts, such as the nitrates of lime, barytes, &c. The alkalies added to these solutions deepened their colour, and, after some hours, rendered them turbid. These solutions produced brown precipitates from a solution of glue or isinglass; the precipitate was insoluble in cold, or even boiling water. From these properties it appeared that

this factitious substance resembled the natural tannin, and was exempt from gallic acid, and mucilage, which commonly accompany it, and alter the colour and appearance of some of the precipitates.

Similar products were afforded by the carbonaceous residuum of isinglass; and we may even assert, that one part of the skin of an animal may be employed to convert the other into leather.

Coak afforded the same product, but without the appearance of the deep yellow substance.

The artificial production seems to be best effected when the carbone is uncombined with any other substance, excepting oxygene: for Bovey coal having the appearance of half-charred wood, afforded a yellow solution, which did not contain any tannin, and the predominant substance appeared to be oxalic acid. Bovey coal, more perfectly carbonized, gave a brown solution, which afforded a precipitate with gelatine. The half-charred Bovey coal was ignited in a close vessel; after which nearly the whole was converted into tannin. A coal from Sussex, resembling the second kind of Bovey coal, and surturbrand from Iceland, gave the same results. Deal sawdust afforded oxalic acid, but no tannin: the same sawdust being charred, afforded a liquid which precipitated gelatine. Teak-wood (which contains neither gallic acid nor tannin) was charred, and it then gave the same product.

It is not, however, necessary to reduce organized substances into coal; nor does it appear to be the process used by nature. Mr. H. has used sulphuric acid to carbonize vegetable substances in the humid way.

Concentrated sulphuric acid almost immediately dissolves common turpentine; if this solution is poured into water, the turpentine is separated in the state of common yellow resin; if an hour or more elapses before the solution is poured into water, then dark-brown resin is formed; after four or five hours, the resin is completely black. If the solution be digested for some days, the turpentine will be converted into a black porous coal, which sometimes affords a dark-brown solution with alcohol. This solution yields by evaporation a mass soluble in water as well as alcohol, and which precipitates gelatine, acetite of lead, and muriate of tin, but produces only a very slight effect with oxysulphate of iron.

Common resin treated in this manner affords about 43 per cent. of coal, which, after being ignited, still weighed 30 per cent. and was slowly combustible. By distillation in a *small* retort common resin afforded only $\frac{1}{4}$ per cent. of coal.

To exhibit the production of tannin according to the progressive conversion of the resin into coal, common turpentine was dissolved in sulphuric acid, and from different portions of the solution yellow resin, brown resin, black resin, and coal, were

obtained. Nitric acid was abstracted from these products, and the residua were dissolved in water.

The solution of the residuum of turpentine and that of yellow resin were pale straw-colour, and did not precipitate gelatine; that of brown resin was a deeper yellow, but did not precipitate gelatine; that of black resin yielded a considerable portion of tannin; and that of coal afforded it in great abundance.

Wood, copal, amber, and wax, reduced to coal by sulphuric acid, yielded similar products by subsequent treatment with nitric acid.

Mr. H. suspects that the tannin, which, as above stated, is to be found in the coal thus produced by sulphuric acid, is occasionally formed by nature in peat-mosses. These mosses sometimes contain considerable quantities of tannin, which acts strongly upon animal bodies which have accidentally been exposed to its effects; and Mr. H. is more inclined to suppose that this substance has been formed during the conversion of the vegetable matter into peat, than that it originally existed in the vegetables from whence the peat was produced.

As the principles by which tannin is produced are now developed, Mr. H. hopes that some economical process will in time be discovered, by which the tanner may prepare his leather even from the refuse of his present materials.

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*Additional Experiments on artificial Tannin. By Mr.* CHARLES HATCHETT.—*Phil. Trans. for* 1805, Part II.

THE artificial tanning substance is produced by the action of nitric acid, whilst the varieties of natural tannin are destroyed: this considerable difference indicates that the name of artificial tannin is not strictly proper, and therefore Mr. H. has yielded to the advice of his chemical friends, and left the name to be hereafter determined.

Nitric acid cohobated three times upon artificial tannin did not alter the properties of it; neither did the abstraction of nitric acid from a mixture of equal quantities of this artificial tannin and sugar, or of artificial tannin and gum-arabic.

Isinglass was precipitated by the artificial tannin, and nitric acid was abstracted from the precipitate. The solution of this precipitate exhibited the same phenomena as were produced by the original artificial tannin. When muriatic acid was abstracted from the precipitate formed by isinglass and artificial tannin, only a small portion of the residuum is soluble in boiling water; the solution is of a dark beer-colour; it does not precipitate gelatine, but it yields an ash-coloured precipitate with muriate of tin, and a slight deposition of a reddish brown colour with sulphate of

iron. The undissolved residuum was treated with nitric acid; it was thus rendered soluble in water, and its solution precipitated gelatine.

Muriatic acid being abstracted from artificial tannin, did not alter any of its properties: this substance seems also to be completely imputrescible, and, unlike the infusions of galls, sumach, catechu, &c. it never becomes mouldy.

Having thus ascertained the unchangeable nature of the artificial tannin, the following comparative experiments were made.

Galls were dissolved in nitric acid, the solution evaporated to dryness, and the residuum dissolved in water. This solution did not produce the smallest effect on dissolved gelatine.

A strong infusion of galls was evaporated to dryness, and treated as above; but no trace of tannin could be discovered. The same effect took place with the precipitate formed by infusion of galls with isinglass, and also with sumach.

Pegu-cutch, and the catechu, called kascutti, afforded much oxalic acid, but no vestige of tannin; the solution of the residuum left by common catechu, or by prepared oak-bark, rendered the solution of isinglass a little turbid; a tenacious film was deposited, which was insoluble in boiling water, and was evidently composed of gelatine and tannin.

Infusions were prepared, as nearly as possible of equal strength, from galls, sumach, shavings of oak-wood, oak-bark, and artificial tannin. To $\frac{1}{2}$ an oz. in measure of each was added a drachm in measure of strong nitric acid: the several infusions were then examined by solution of isinglass. Those of galls, sumach, oak-wood, were not rendered turbid; those of oak-bark and of artificial tannin continued to precipitate gelatine till 4 drachms (or $\frac{1}{2}$ an oz.) of nitric acid had been added to each of the infusions.

The pegu-cutch is replete with mucilage, and appears to be the most destructible of all the varieties, on account of the presence of this matter; we shall also see hereafter the mixture of gum or of mucilage prevents, more or less, the formation of artificial tannin.

Sulphuric acid renders a solution of artificial tannin turbid, and throws down a copious brown precipitate, soluble in water, and then precipitating gelatine. Muriatic acid has the same effect. Carbonic acid deepens the colour; after which the solution becomes turbid, and deposits a brown magma.

Ammonia dissolves artificial tannin. The solution evaporated to dryness and dissolved in water did not precipitate gelatine, unless a small quantity of muriatic acid was added. When the solution in ammonia was evaporated, some ammonia arose, and then a yellow liquor, which had the odour of burnt horn; the residuum was nearly insoluble in water, and communicated only a slight yellow tinge to it.

Artificial tannin placed upon a hot iron emits an odour very

analogous to those of burnt animal substances: on distillation it yielded a small portion of water; a little nitric acid from which it had not been completely freed; a gas, which, by the quickness in which it was produced, overset the jar placed to receive it, and which by its odour appeared to be ammonia; carbonic acid very slowly produced; azote; and, lastly, a bulky coal, yielding brownish-white ashes, consisting principally of lime, as only very slight traces of alkali could be observed.

Fifty grains of artificial tannin were dissolved in 4 oz. of water, and precipitated by dissolved isinglass, 81 gr. of which combined with 46 of the tannin. The remaining 4 gr. were not precipitated; the solution containing them was separated by filtration, and evaporated to dryness. The residuum was a light brittle substance of a pale cinnamon-brown colour, possessed of a strong odour not unlike prepared oak-bark, and very soluble in water. The solution is extremely bitter; it acted very slightly on dissolved isinglass; it produced a brown precipitate with sulphate of iron, a blackish-brown one with muriate of tin, and a copious pale-brown one with acetite of lead; but it did not affect nitrate of lime. When added to a solution of carbonate of ammonia, it produced some effervescence; but its peculiar odour did not suffer any diminution.

Mr. H. made several unsuccessful attempts to produce artificial tannin by the oxygenized muriatic acid; he also found, that although a variety of this substance could be produced by the action of sulphuric acid on resinous substances, yet the most effective agent was nitric acid, which readily formed it from any sort of coal. With a view, however, to determine whether it could be procured from vegetables without previously converting them into coal, he made the following experiments:

Nitric acid abstracted from indigo left a deep orange residuum, the greater part of which was taken up by water, and formed a most beautiful deep yellow solution, of a most intense bitter flavour. This solution yielded with sulphate of iron a slight pale yellow precipitate; it rendered nitrate of lime only a little turbid, and flung down a small quantity of oxalate of lime; with muriate of tin it yielded a copious white precipitate, which changed to a yellowish brown; with acetite of lead it formed a very beautiful lemon-coloured precipitate, which may be useful in painting. Ammonia deepened the colour of the solution, which then became turbid, and deposited fine yellow spicular crystals, the solution of which in water did not precipitate lime from its solutions; these crystals were very bitter. Dissolved isinglass added to the yellow solution of the residuum, rendered it turbid; a bright yellow film was deposited, insoluble in boiling water, and possessing the characters of gelatine combined with tannin.

In his former paper, Mr. H. had stated that common resin, when treated with nitric acid, yielded a pale-yellow solution with

water, which did not precipitate gelatine; but he now found, that upon repeating the abstraction of the nitric acid several times, the solution of the residuum in water formed a tough yellow precipitate, insoluble in boiling water: it formed a slight yellow precipitate, with sulphate of iron: it did not produce any effect with nitrate of lime; with nitrate of tin it yielded a pale brown precipitate, and it formed a yellowish white one with acetite of lead.

During the abstraction of the nitric acid, nitrous gas was disengaged, which indicated the cause of the change produced in the resin. The same process was extended to other juices of plants, and the effects are thus stated.

Stick-lac, treated as the resin, copiously precipitated gelatine.

Balsam of Peru afforded some benzoic acid during the process, and gelatine was precipitated by the solution of the residuum.

Benzoin afforded benzoic acid, and the solution of the residuum was nearly similar in all its properties to that above described.

Balsam of Tolu afforded benzoic acid, and the solution of the residuum precipitated gelatine.

Dragon's blood, or at least a sample of it in a porous mass of a dark red procured from a druggist in London, yielded benzoic acid; although none could be obtained by simple exposure to heat. The solution of the residuum was nearly similar in its properties to that of resin; it also precipitated gold in its metallic state, whilst the glass vessel acquired a tinge of purple.

Gum-ammoniac afforded a very bitter, astringent, brownish-yellow solution. By sulphate of iron the solution became of a darker colour, but did not form any precipitate. Nitrate of lime produced a slight precipitate. Muriate of tin, as also acetite of lead, yielded a copious yellow precipitate: it was precipitated by gelatine.

Asa-fœtida yielded a solution which precipitated gelatine.

Elemi, tacamahaca, olibanum, sandarac, copaiba, mastic, myrrh, gamboge, caoutchouc, and sarcocol, as also the gum separated from it by water, were examined. Their solutions did not affect gelatine, but they precipitated the metallic solutions. Mr. H. thinks they might have affected gelatine, had the abstraction of the nitric acid been oftener repeated.

Gum-arabic afforded oxalic acid, but no tannin.

Tragacanth yielded abundance of saccholactic, of oxalic, and of malic acids, but not the smallest vestige of artificial tannin.

Manna afforded oxalic acid; the residuum formed a brown solution, which yielded a pale yellow precipitate with sulphate of iron. Muriate of tin produced a pale brown precipitate. Acetite of lead formed one of a brownish-white hue. Oxalate of lime was produced from the nitrate; but the solution of isinglass was not affected.

Liquorice afforded a solution similar to that from manna; but sulphate of iron, as also muriate of tin, produced a slight brown precipitate. Acetite of lead formed a brownish-red deposit; nitrate of lime yielded a brown precipitate; and the solution of isinglass yielded a yellowish-brown precipitate, insoluble in water.

Guaiacum afforded a residuum almost totally soluble in water; the solution of which acted on the metallic salts in a manner similar to the above; but with gelatine it formed only a very slight precipitate, soluble in boiling water; the remainder of the solution being evaporated, yielded a very large quantity of oxalic acid; so that it was totally unlike the resins.

Although many vegetable substances, when roasted, afford by decoction a liquid that resembles the solution of the artificial tannin in water, yet it seems some peculiar nicety is required in the roasting, before the tanning substance is developed. The decoction of roasted common peas, horse-beans, barley, and wheat-flour, did not afford any precipitate by solution of isinglass. Decoction of coffee did not yield any precipitate until several hours had elapsed, and the precipitate was permanently soluble in boiling water. The decoction of a sort of coffee prepared from the chicorée (Mr. H. supposes this to be endive root), did not afford an immediate precipitate with solution of isinglass; the precipitate was soluble in boiling water; but upon cooling, the precipitate again fell down in its original state.

The addition of nitric acid to these decoctions, evaporation of the mixture to dryness, and solution of the residuum in water, converted them into artificial tannin.

In addition to his former observations on the variety of artificial tannin, which was formed by the action of sulphuric acid upon resinous bodies, Mr. H. relates the following experiments upon camphor:

One hundred grains of camphor were dissolved in an ounce of concentrated sulphuric acid, a brown solution was formed, with the disengagement of scarcely any sulphureous acid; but in about an hour the liquor became blackish-brown, much sulphureous gas was then produced, and continued to increase during four hours, when the whole appeared like a thick black liquid. This evolution of sulphureous acid continued for two days, even in the cold. By the application of heat it was renewed. Six ounces of cold water being added on the fourth day, the liquid was changed to reddish-brown, a coagulum of the same colour subsided, and the odour of sulphureous acid was succeeded by that of a mixture of oils of lavender and peppermint. Distillation separated three grains of an essential oil, to which this smell was owing: two ounces more of water being abstracted did not bring off any more essential oil. The blackish-brown residuum of this distillation was treated with successive portions of alcohol until this solvent ceased to act.

A compact sort of coal in small fragments was left undissolved, which, after being dried and exposed to a low red heat, weighed fifty-three grains. The solutions in alcohol were distilled to dryness, and forty-nine grains of a blackish-brown substance of a resinous appearance were obtained.

This substance was extremely brittle, had the odour of burnt sugar, and an astringent flavour: it was soluble in cold water, and formed with it a dark-brown solution, which yielded very dark brown precipitates with sulphate of iron, acetite of lead, muriate of tin, and nitrate of lime: it precipitated gold from its solution in a metallic state: with solution of isinglass it yielded a black precipitate, insoluble in boiling water: so that it appears to be a variety of the tanning matter, and to resemble that obtained from resinous bodies by sulphuric acid.

When a small quantity of nitric acid was added to the solution of this substance, the whole evaporated to dryness, and the residuum dissolved in water, a reddish-brown liquid was formed, which acted in every respect similar to the tannin obtained from coal by nitric acid.

It appears therefore that there are three varieties of artificial tannin:—First, That produced from nitric acid and any carbonaceous substance. This is easily formed: one hundred grains of vegetable charcoal yield about one hundred and twenty grains of it; but we must allow three grains for the moisture that remains united with it. This variety probably contains azote. It differs from the natural tannin of vegetables in being produced by nitric acid; whereas the varieties of natural tannin are more or less destroyed by that acid; but it must be confessed, that even the varieties of natural tannin are destructible in different degrees.

The second variety is obtained from resins, &c. by abstraction of nitric acid. The precipitates it forms with gelatine are either pale or deep yellow; those of the first variety are always brown. The production of benzoic or oxalic acid appears to counteract the formation of this substance: so that it is probable that the benzoic acid is actually produced in these experiments, and that it does not exist, as has been usually supposed, in the balsams. Mr. H. also thinks, that the succinic acid is a product of amber, and not an original ingredient in it.

The third variety is produced by the action of sulphuric acid on resins, &c. By a long continuance of the digestion it appears to be destroyed. Those substances which afford much oxalic acid with other acids do not apparently yield any of this artificial tannin: its action on gelatine and skin is inferior to that of the first variety, into which, however, it is converted by treatment with nitric acid. This process probably communicates to it the azote; to the want of which its less powerful action may be attributed.

*Observations.*—These experiments of Mr. H. are of great importance in the theory of chemistry; but whether they will lead to any great improvements in the art of tanning, is very doubtful. The use even of the purer varieties of natural tannin seems to be injurious to the leather, as they induce brittleness; the presence of extractive matter being necessary to the softness and strength of the leather: and therefore it is probable that the use of a still purer variety of tannin must have still worse effects.

It is not a little curious to observe the discoveries that are missed even by the most intelligent observers. Mr. H. misled, we apprehend, by the authority of Haussman, missed the discovery of the yellow acid. This discovery was reserved for Fourcroy and Vauquelin. On the other hand, the French chemists, when operating on the same materials, as may be seen in the abstract of their memoirs, which are given in the last and present number, equally missed the discovery of the artificial production of a substance similar in its properties to tannin.

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*On the Effects which take place in the Gases, when mechanically compressed. By Mr.* Thomas Northmore.—*Phil. Jour.* Nos. 49 *and* 52.

It occurred to Mr. N. that the various combinations that take place among the gases under the common pressure of the atmosphere would undergo considerable alteration by the influence of condensation. Great difficulties were experienced in attempting experiments upon this foundation, on account of the corrosive quality of some of the condensed fluids, which spoiled the stop-cocks attached to the receivers. Mr. Cuthbertson, however, contrived a valve which, by means of a spiral spring, applied itself to the lower orifice of a condensing syringe; and this answered Mr N.'s purposes.

The four first experiments were made in a glass receiver, holding $3\frac{1}{2}$ cubic inches; and with stop-cocks, which let the gas escape: the others were made with a glass receiver, holding $5\frac{1}{2}$ cub. inches, and with a spring valve to the syringe.

*Exp.* I. Hydrogen, oxygen, and azote, of each two wine pints, were compressed. The result was water, white floating vapours, which Mr. N. conceived to be gaseous oxide of azote, and an acid which reddened litmus paper, and was probably the nitric.

*Exp.* II. A little lime-water was poured into the receiver; three pints of oxygen were then injected, and afterwards equal quantities of hydrogen and azote. Upon adding the latter, the white vapours appeared, water seemed to be formed, and some

yellow particles were seen floating upon the lime-water. These probably arose from the resinous cement of the cap being dissolved by the nitrous acid gas formed during condensation.

The magnet seemed affected during this experiment.

*Exp.* III. Carbonic acid gas, and hydrogen, of each two pints, yielded a watery vapour, and a gas of a rather offensive smell.

*Exp.* IV. Atmospheric air condensed upon phosphorus caused an explosion. The apparatus was under water; the receiver was full of the fumes of the phosphorus, which was itself dispersed in the vessel of water.

On repeating this experiment with the more perfect apparatus, the phosphorus did not inflame, and the fumes which arose at first soon disappeared.

*Exp.* V. Two scruples of solution of potash were poured into the new receiver; and two pints of hydrogen, and of azote, as also three of oxygen, were injected, The results were, a smell of the gaseous oxide of azote, a few yellowish fumes, and so little acid as scarcely to tinge the edge of the test-paper. Nitrate of potash was not formed.

*Exp.* VI. Two pints of azote being condensed, it assumed an orange-red colour; three of oxygen being added, the colour seemed at first to be deepened; it then diminished, and at length disappeared: two of hydrogen being added, produced vapours which, when condensed, were strongly acid to the taste, coloured litmus, and, when much diluted with water, acted upon silver.

*Exp.* VII. Three pints and a half of azote were first injected, then two pints of hydrogen, which produced white clouds, supposed to be ammonia; these disappeared, and the orange-red colour became lighter. On the addition of three pints and a half of oxygen the colour became, if any thing, darker. Two pints more of hydrogen had little or no effect on the colour. Some vapour was produced, which was strongly acid.

*Exp.* VIII. Before the small receiver burst, three pints of azote had been injected upon a scruple of lime; a little reddish colour was produced, which soon vanished. Upon repeating the experiment with the large receiver, no colour was produced.

During the course of the above experiments, the temperature of the atmosphere was very various, from 70° to 33° Fahr.

It is not to be supposed that the quantity of the gas said to be injected is certain, on account of its tendency to escape.

On repeating *Exp.* VIII. it was found that the loss of colour in the azote arose from the formation of nitrate of lime.

*Exp.* IX. A pint of azote was condensed, and another of gaseous oxide of carbone added to it. The red colour was destroyed, nitrous acid was formed, and the remaining gas burnt not unlike alcohol.

As azote is highly elastic, it is suspected that the explosive force

of various compounds, as fulminating gold, fulminating silver, many of the nitrates, and the decomposition of ammonia by oxygenized muriatic acid, may be attributed to the sudden liberation of this gas.

*Exp.* X. Oxygen condensed upon phosphorus did not inflame it; it appeared disposed to melt, and seemed a little discoloured. Some heat is generated by the condensation of the gas, for the thermometer rises, when placed against the receiver.

*Exp.* XI. Two pints of oxygenized muriatic acid being compressed into a receiver of two and a quarter cubic inches capacity, it was converted into a yellow liquid, which instantly evaporated, on opening the receiver, with an insupportable pungency. Atmospheric air pumped into the receiver, filled it with dense white fumes. A yellowish substance was left, which dissolved in sulphuric ether, and destroyed vegetable colours. This probably arose from the oil of the machine.

*Exp.* XII. Upon half a pint of oxygen was injected a pint of oxygenized muriatic acid gas: the result was a thicker substance, which did not so soon evaporate, and a yellowish mass was left behind.

*Exp.* XIII. A pint of oxygenized muriatic acid gas was injected upon half a pint of azote: the result was a still thicker substance, and the yellow colour was deeper: it did not appear to act so powerfully upon vegetable colours.

The grease carried down formed part of the yellow residuum, and yielded only to ether.

*Exp.* XIV. Into a receiver, whose capacity was three cubic inches, a pint of carbonic acid gas was condensed, and a pint of oxygenized muriatic acid gas was added to it. A light sap-green colour was produced, but no fluid; the oil of the machine destroyed vegetable colours.

*Exp.* XV. Two pints of oxygenized muriatic acid gas were injected into rather more than a pint of hydrogen, which was highly elastic. A light green colour was produced, but no fluid. When the receiver was opened, some vapour made its escape, and the gas destroyed vegetable colours.

*Exp.* XVI. When a small quantity of muriatic acid gas was condensed, a beautiful green substance adhered to the side of the receiver, which had all the qualities of muriatic acid. When four pints were condensed, the result was a yellowish green glutinous substance of a very pungent quality, which did not evaporate, but was instantly absorbed by water.

This acid gas is so easily rendered liquid, that any quantity may be condensed without danger; and it is probable that compression may be of some use in the arts to obtain muriatic acid, oxygenized muriatic acid, and some other fluids at any degree of concentration.

*Exp.* XVII. A pint and a half of sulphurous acid gas being attempted to be condensed, had so violent an action on the syringe as to render it immoveable. A thick slimy liquid of a dark yellow colour had begun to be formed, which, on opening the receiver, immediately evaporated with a most suffocating odour.

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*On the Production of nitrous Acid. By* H. B. K.—*Phil. Jour.* No. 50.

The galvanic fluid passed through liquid carbonate of potash caused the emission of a great quantity of carbonic acid gas. A piece of paper, dipped into the residual fluid, detonated, when burned, as nitre would have done; a solution of silver also shewed faint indications of the muriatic acid being present in the residuum. The same acids appeared on firing hydrogen with oxygen.

Pure distilled water by the galvanic fluid gave oxygen and hydrogen.

Pure potash dissolved in water, and galvanized, did not yield any gas, unless it was carbonic acid gas. The solution appeared to contain the nitrous and muriatic acid, as in the experiment with carbonate of potash.

Hence it is probable that the expulsion of carbonic acid from the carbonate of potash was caused by the presence of a stronger acid. It appears also, that the generation of oxygen and hydrogen is owing to these acids; for when potash was present to absorb them, these gases were not produced. This is the more probable, because the residual water, in the experiment in which they were produced, did not contain them. And Mr. Cruickshanks says, that in firing these gases, he found nitrous acid in the residuum.

These experiments were performed by two short gold wires attached to each end of the galvanic pile. When a pretty long iron wire was attached to the silver end of the pile, a little hydrogen gas was produced, even when potash was mixed with the distilled water, although there was none with the gold wire.

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*On the Composition of Water, and on Mr. Northmore's first Experiments on the Compression of the Gases. By* H. B. K.—*Phil. Jour.* No. 52.

In the preceding paper by this anonymous writer, on the production of nitrous acid, he attempted to shew that acids were necessary in forming oxygen and hydrogen from water. Having collected a quantity of these gases, they were fired in

contact with a small quantity of solution of potash. Vapours of nitrous acid appeared, and the potash gave unequivocal signs of the presence of nitrate of potash.

In Mr. Riffault's second experiment, the wires were oxidized; but when the author repeated this experiment, and used a solution of potash in lieu of water, the wires were not sensibly acted upon, and the potash became nitrated. This experiment, the author thinks, is conclusive.

The gases obtained from the decomposition of water by galvanism are not always in the same proportion, as stated by the French chemists. The respective quantities depend upon the metals of which the wires are made, their length, and the liquors between the plates of the pile; the more oxidizable wires, when long, producing the most inflammable kinds; and the less oxidizable wires, the more of oxygen. The longer the wires, the greater was the bulk of the gas obtained.

In respect to Mr. Northmore's first eight experiments, it has been long known that gases by compression produce heat and deposit water. The white vapours in the first experiment are considered as gaseous oxide of azote; those in the seventh are considered as ammonia, just as the French theory dictated to him. The same ardent desire to support that hypothesis at all events, is evident through the whole recital. In the fifth experiment, the gaseous oxide is stated to have had a yellowish colour instead of white.

The acid produced is pronounced by Mr. N. to be the nitrous. The yellow flocculi in the second experiment are said to be resin extracted from the cap; but the author is of opinion, that it is merely a precipitation in the lime-water from some carbonic acid being produced, which appeared yellow on account of its being seen through coloured gases. He also supposes, that as an acid is necessary to the formation of oxygen, so it is separated in its decomposition, either in the form of nitric acid, as when it is decomposed with violence; or in that of carbonic acid when slowly decomposed, as in Mr. N.'s experiments.

In the fifth experiment, Mr. N. says very little acid was produced, and nitrate of potash was not formed, because the quantity used of the gases was not sufficient; yet in the sixth experiment, with the same quantities and in the same vessel, a strong acid was produced, which, when diluted, acted upon silver. But was not carbonic acid produced in the fifth? and is Mr. N. ignorant that water impregnated, as this probably was, with hydrogen, will colour silver?

It is strange that an acid sufficiently strong to act upon the resin in the cap of the vessel could not be detected when an alkaline basis was added to arrest it.

In the seventh experiment, Mr. N. further supposes that ammonia was first formed; and yet the result is stated to be highly

acid. Why did not this strong acid, which was able to act upon resin, unite with the ammonia?

On repeating the third experiment of Mr. N. the gas produced was found to be similar to the gaseous oxide of carbone.

The gases were compressed still more than in Mr. N.'s experiments, by using a brass cylinder with an air-tight iron piston affixed to the end of a long iron lever. They all gave out heat and moisture, and the hydrogen most moisture in proportion to its specific gravity. Oxygen, compressed along with hydrogen, yielded an acid which produced flocculi in lime-water; azote was not necessary to its production, but rather retarded it. Azote from organic bodies ought not to be used, because it is partly acid in itself; but azote from the atmosphere should be employed, and it should be previously passed through lime-water.

*Observation.*—The contradictory facts in these papers are such as can be cleared up only by fresh experiments, made by unprejudiced persons.

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*Analysis of the Ichthyophthalmite. By* M. Rose.—*Jour. de Phys. Vendem.* xiv.

The products were 52.0 of silica, 24.50 lime, 8.10 of potash, and 15.0 parts were volatilized and lost.

*Observation.*—If it had not been of importance to confirm the analysis of former chemists by the observations of their successors, it would have been needless to insert this analysis, which nearly agrees with that of Fourcroy and Vauquelin, mentioned in our first volume, page 376.

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*On native Iron, and a new native Sulphuret of Manganese. By Prof.* Proust.—*Jour. de Phys. Vendem.* xiv.

Proust has found native iron in some minerals from America: it is imbedded in them, so as to be preserved from the contact of the air: and when they were reduced to powder, the native iron was separated by the magnet. This iron yielded by solution in dilute sulphuric acid very pure hydrogen. The minerals were so soft, that it was not likely that the iron could not be abraded from the pestle or mortar.

Del Rio has found another native sulphuret of manganese.

*Observation.*—As the minerals are not described, it is possible that they may be meteoric stones, in which the presence of native iron has been shewn by Howard, &c.

# REVIEW OF SPECIFICATIONS OF PATENTS,

PUBLISHED IN THE REPERTORY OF ARTS, &c. IN THE MONTHS OF JANUARY, FEBRUARY, AND MARCH, 1806.

*Mr.* ARTHUR WOOLF's *Patent for certain Improvements in Steam-engines. Dated July* 1805.—*Repert. Arts,* No. 44, *New Series.*

AMONG the improvements to be secured by this patent are, first, a contrivance by which the temperature of the steam-vessel, or working cylinder of a steam-engine, may be raised to any required degree [the specification has it *temperature*], without admitting steam from the boiler into any surrounding receptacle, which is always attended with a risk of explosion proportioned to the elasticity of the steam employed: Mr. W.'s method is to put into the surrounding receptacle, oil, or fat, or wax, &c. capable of being melted by a lower degree of heat than that employed, and of bearing that heat without being converted into vapour. Or he puts into the said case or cases mercury or mixtures of metals, capable of being kept in a state of fusion at a lower temperature than that intended to be employed in working the steam-engine, and forms the case, so that it admits the oil or other substance employed to come in contact not only with the sides of the steam-vessel or working cylinder, but also with the bottom and top of the same; and the temperature is kept up by a fire immediately under or round the case that contains the oil or other substance, or by connecting the case with a separate vessel kept at a proper temperature, filled with the oil or other substance. This arrangement is intended to obviate the necessity of employing steam of a great expansive force round the steam vessel or vessels; and to obtain from steam of a comparatively low temperature, the effects of steam of a high temperature, without any of the risk accompanying the latter.

Another supposed improvement consists in a method of preventing the passage of any of the steam from that side of the piston which is acted upon by the said steam to the other side which is open to the condenser; and this he effects in those steam-engines called *double* engines, by employing upon or about the piston, mercury or fluid metals, in an altitude equal to the pressure of the steam. The efficacy of this arrangement will, he says, "appear obvious from attending to what takes place in the

working such a piston." He then proceeds thus: "When the piston is ascending, that is, when the steam is admitted below the piston, the space on its other side being open to the condenser, the steam endeavouring to pass up by the side of the piston, is met and effectually prevented by the column of metal, equal or superior to it in pressure, and during the down stroke, no steam can possibly pass without first forcing all the metal through. In working what is called a single engine, a less considerable altitude of metal is required, because the steam always acts on the upper side of the piston. For single engines, oil or wax, or fat of animals, or similar substances in sufficient quantity, will answer the purpose, if another improvement, which constitutes part of my said invention, be applied to the engine; namely, to take care that in either the double or single engine so to be worked, the outlet that conveys the steam to the condenser shall be so posited, and of such a size, that the steam may pass without forcing before it or carrying with it any of the metal or other substance employed, that may have passed by the piston; taking care at the same time to provide another exit for the metal or other substance collected at the bottom of the steam-vessel or working cylinder to convey the same into a reservoir kept at a proper heat, whence it is to be conveyed to the upper side of the piston by a small pump, worked by the engine or by any other contrivance. In order that the fluid metal or metals used with the piston may not be oxidated, I always keep some oil or other fluid substance on its surface, to prevent its coming in contact with the atmosphere; and to prevent the necessity of employing a large quantity of fluid metal, I generally make my piston of the depth of the column required, but of a diameter a little less than the steam-vessel or working cylinder, excepting where the packing or other fitting is necessary to be applied; so that, in fact, the column of fluid metal forms only a thin body round the piston. In some cases, I make a hollow metallic piston, and apply an altitude of fluid metal in the inside of the same, to press its outside into contact with the steam-vessel or working cylinder."

Such are the chief points in the specification. The same principles are applied to some minuter particulars, which, however, need not be here individually described.

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*Observations.*—The eagerness of Mr. Woolf to come forward, vaunting his discoveries in fresh specifications, is similar to that with which a child runs to his parents with every trifle that strikes him as novel, in the same manner that it presented itself to other children a hundred years ago; and the unaccountable zeal of some of his friends to get these supposed discoveries published, can only be compared to the misemployed fondness of some doting parents, who, looking upon their child as a prodigy,

are not satisfied unless all the world agree with them in their preposterous notion. We have seen the praises of Mr. W.'s inventions blazoned forth in several respectable publications, and know not how to account for such encomiums from gentlemen who, we are sure, know better, if it may not be imputed primarily to some such cause as we have just adverted to. We think it our duty to strive to prevent the public from being deluded by any specious pretensions, and shall, therefore, direct our remarks not only to the present specification, but to some of Mr. Woolf's preceding inventions; one or two of which were briefly noticed at page 79 of our first number.

The first supposed improvements of this engineer related, we believe, to boilers; and the chief of these *improvements* was, it is well known, suggested by Mr. Blakey at least 30 years ago, and was afterwards abandoned on account of its inutility.

The next improvement, or rather discovery, was stated in the specification of June 1804, and relates to the expansive force of steam.

Thus, to select two or three instances from Mr. W.'s table: "Steam of an elastic force predominating over the pressure of the atmosphere upon a safety-valve, 5, 6, or 7 lbs. per square inch, requires to be maintained by a temperature equal to about $227\frac{1}{2}°$, $230\frac{1}{4}°$, $232\frac{3}{4}°$ of heat; and at these respective degrees of heat steam can expand itself to about 5, 6, or 7 times its volume, and continue equal in elasticity to the pressuse of the atmosphere." Does Mr. W. mean to affirm that it is *his* discovery, that steam of an elastic force, exceeding the pressure of the atmosphere by 5, 6, or 7 lbs. on the square inch, has nearly the respective temperatures of $227\frac{1}{2}°$, $230\frac{1}{4}°$, and $232\frac{3}{4}°$, measured by Fahrenheit's thermometer? On the contrary, we assert, and we are prepared to prove our assertion, that the same was discovered long ago by the Chevalier Bettancourt, and has been completely established so long back as 1801 by our ingenious countryman Mr. Dalton. It is nearly deduced from the tables given by this gentleman in the *Manchester Memoirs*, vol. v., that steam of the respective temperatures of $227\frac{1}{2}°$, $230\frac{1}{4}°$, and $232\frac{3}{4}°$, exceeds in elastic force the pressure of the atmosphere by about 4·998, 5·968, and 6·934 lbs. on the square inch: results which it is manifest differ very little from those of Mr. W. and are probably more accurate. Here then Mr. W. has been anticipated in his *discovery* by two philosophers, the results of whose experiments have been often published. But perhaps the patentee will relinquish his claim to this discovery, and rest his pretensions upon having found that steam whose elastic force surpassed the pressure of the atmosphere by 5, 6, 7, &c. lbs. on the square inch, would, when expanded to 5, 6, 7, &c. times its volume, still possess an elastic force at least equivalent to the pressure of the atmosphere: of this, however, we have very serious doubts; for although at first view it may appear

to accord with the statement of Sir Isaac Newton, that *if steam be a perfectly elastic fluid, its elasticity will be inversely as the space it occupies* (a proposition which Mr. W. may find either demonstrated or illustrated in any treatise on Pneumatics that may fall in his way), it is nevertheless essentially different from it. So much for this gentleman's *discoveries*; let us now proceed to his *inventions*.

Mr. W. has succeeded (some years after Trevithick had done the same thing) in the application of steam of high temperature to the purpose of working an engine; and as to the *manner* of applying this principle, it is most unequivocally Jonathan Hornblower's engine, working with steam of superior strength to what he made use of.

But Mr. W. it seems, has "found out and invented" something, by which the steam-vessels may be kept hot without steam from the boiler; and how admirable is the contrivance! for he does it by putting *a fire* under them. Again, he substitutes oil, wax, or metals, in his casings, instead of steam: and what then? Will not the oil, or wax, or metals, however heated, be in contact with the casing? And will not that casing transmit the heat of these substances to the surrounding substances, whether air, wool, wood, or sawdust, &c.? And can there be any more magic in these substances to preserve the temperature attained by the fire under the vessels, than there is in the cast iron of which the cylinders are made? Here, however, as to the priority of the discovery, we may refer to the specification of Mr. Watt's first patent, inserted in the first volume of the Repertory of Arts, &c. page 278, where are the following words, bearing a close analogy to some in Mr. Woolf's specification: "The steam-vessel must be kept as hot as the steam that enters it; first, *by enclosing it in a case* of wood, or any other materials that transmit heat slowly; secondly, by surrounding it with steam, *or other heated bodies*." Again, Mr. Watt, in the same specification, dated Jan. 5, 1769, says, "Lastly, instead of using water to render the piston or other parts of the engines air and steam tight, I employ *oils, wax, resinous bodies, fat of animals, quicksilver*, and *other metals*, in their fluid state." And these are the very substances recommended by Mr. Woolf thirty-six years afterwards.

But more than this: the patentee has invented a method of working an engine without any boiler at all, even by admitting water into his hot cylinders, which, brought to ever so high a temperature, cannot explode. What a palpable absurdity! Another invention is, a method of preventing the steam from escaping between the sides of the piston and the cylinder, by pouring quicksilver round the disc of the piston. Mr. W. happens to think that the steam cannot ascend through a column of mercury, and therefore says it is *obvious*. We are decidedly of a different opinion; but are not willing to fatigue our readers by an extension of these remarks. The grand object proposed

to be gained by the application of Mr. W.'s *discoveries* and *inventions* is a saving of fuel; but few reflecting men will, we conceive, expect a saving from such a Babel-like composition of things as these specifications enumerate. Mr. W. probably possesses ingenuity: we would recommend to him to make himself acquainted with what has been done by his predecessors, before he publishes any more *discoveries*; and would advise, moreover, a fondness for simplicity of construction, rather than for complication and parade.

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*Mr.* William Deverell's *Patent for certain Improvements in the Steam-engine. Dated August* 1805.—*Repert. Arts,* No. 44, *New Series.*

The proposed improvements of this patentee consist, 1. In the manner and form of constructing the fire-place: 2. The manner of using the steam: 3. An improvement on the cold liquor pump. The principal of these is that of connecting the steam-boiler with three iron cylinders, filled with water, instead of connecting it with brick-work. Instead, however, of being in three detached cylinders, they may be cast whole, or made of wrought iron, to form the fire-place, but which will be attended with more trouble: these cylinders, says the patentee, may be used to great advantage where large boilers are already set; and being applied to engines of various powers, will, with the same fuel, be capable of doing more work with the steam arising from them. "In the present mode of setting boilers," says Mr. Deverell, "the brick-work underneath them is attended with frequent repairs, owing to the action of the fire upon them; nor is this expense the only inconvenience attendant upon them; the whole concern is for the time they are repairing wholly stopped."

To explain the second improvement as perspicuously as possible, without a diagram, we must observe, that two working cylinders are placed near to each other, each having a pipe of communication with the steam-vessel, near which they both stand. The pistons in the two cylinders work alternately to and again, by means of valves or cocks, opening and shutting as in the common engine. The steam-vessel at the end of the stroke, the patentee says, will be full of steam of about 18 lbs. pressure; and that it should be about 26 times larger in capacity than the smallest working cylinder; the larger it is, the more regular will be the pressure on the piston. If the steam in the boiler be of 54lbs. pressure, the ratio of the two working cylinders may be as one to three; for then the smaller one will supply the larger with steam of about 18 lbs. pressure: the proportions, however, may be varied; though these are thought best by the patentee. The improvements here are represented to

consist in the steam going from the smaller working cylinder to the steam-vessel, and then from the steam-vessel to the larger working cylinder, in which it is condensed; and that by these means the engine will be very regular in its operations. The steam in the boiler being supposed at 54 lbs. the smaller cylinder will, at the end of the stroke, be full of steam of the same, or nearly the same force; and the steam-vessel being full of steam of about 18 lbs. the communication being open between this and the smaller cylinder, the steam in each of these will be brought to nearly 20 lbs. pressure. But at the end of each stroke of the pistons, before the opening is made between the smaller cylinder and the steam-vessel, the steam in the smaller cylinder will be at about 54, in the steam-vessel at about 18, and in the larger working cylinder at about 18 also: hence the medium pressure on the piston of the smaller vessel will be about 35 lbs. in the inch; while the medium pressure of the steam on the piston of the cylinder will be about 19 lbs. on the inch. If the steam-vessel be made larger, the difference at each end of the stroke will not be so great: were the steam let out at 54 lbs. to the open air from the smaller cylinder, there would be but 39 lbs. upon the inch, in consequence of the re-action of the atmosphere equivalent to about 15 lbs. per inch. Thus, by letting the steam pass from the smaller cylinder to the steam-vessel, instead of letting it out to the open air, it loses about 4 lbs. on the inch; but it gains on a piston three times as large about 12 lbs. on the inch; and there being but half the steam to condense required in the common way, there must of necessity be a considerable gain. If the friction of the piston be 9 lbs. on the inch in the smaller cylinder, there will be but about 30 lbs. on the inch neat power, when the larger one will work about 12 lbs. on the inch. Here too, if the large cylinder, or piston, or air-pump, or condenser, should be out of order, the small piston may still be worked by disengaging the large piston from the beam; on the other hand, if the smaller piston be out of order, the large one may still be worked, while the other is disengaged.

The cold liquor pump has a hollow piston, at the bottom of which is a small pin, which, when taken out, admits water through the piston into the pump-barrel to displace the air. At the bottom of the pump-barrel the passage is narrowed so as to form a seat for a globular valve, this valve being either lifted or let down by a small chain made fast to a transverse pin, and in the latter case stopping the communication between the pump-barrel and a large cistern below it. By means of this communication, gravel, sand, &c. may be let fall from the pump-barrel into the cistern; and at the bottom of the cistern there is a little door or falling valve, which, by means of a cord passing out diagonally at the upper part of the cistern, may be lifted up occasionally to discharge the rubbish from the cistern when full.

This, however, is a very obvious manner of effecting the business, and need not be dwelt upon.

*Observation.*—We are inclined to think that Mr. Deverell's improvements will be found, not only to be merely variations unproductive of any advantage, but that his engines will destroy more fuel than those of Mr. Watt's construction.

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*Mr.* Barker Chifney's *Patent for Improvements in the manufacturing and preparing Roofing Slates, and in laying the same. Dated March* 8, 1803.—*Repert. Arts,* No. 44, *New Series.*

This patentee takes the blocks or slabs of slate intended for diamond-cutting, from the common wet saws, after having cut their ends or sides parallel, and then splits them to such thicknesses as may be convenient or necessary. He then puts these slates, intended for diamond slating, on a moving table, when, by two toothed circular saws on one spindle, he cuts the other two sides or ends at right angles to the sides or ends cut by the common wet saws. He afterwards cuts off two corners, opposite to each other, so as to give such overwrapping to the slates as the situations of the buildings or other circumstances may render proper, and then drills the holes for the screws or nails.

For laying diamond slates when rimerheaded are not used, Mr. Chifney bevels the corners cut off, or else files grooves to admit the heads of the nails, which are to be secured with putty.

*Observation.*—The other parts of the specification for making, preparing, completing, and laying *Imperial* slates, may be easily guessed from the preceding, and is in our opinion by much too unimportant to be minutely described.

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*Mr.* John Gregory Hancock's *Patent for a Method of forcing or working the Bolts of Presses or of Engines used for the Purpose of cutting, pressing, and squeezing of Metals, Horn, Tortoise-shell, Leather, Paper, and other Substances. Dated September* 1804.—*Repert. Arts,* No. 44, *New Series.*

The bolts of presses for cutting out, stamping, and impressing metals, &c. are commonly worked by the application of screws, which necessarily have the same alternate advancing and retrograde motion which is required of the bolts. Mr. Hancock's improvement consists merely in substituting for these screws, either spiral or wedge-like wipers, by means of which a reciprocating motion may be communicated to the bolt from a continued rotatory motion of either a vertical or horizontal axle. When the motion is

to be transmitted to the bolt in a direction perpendicular to the axis of the revolving shaft, the wipers are to be in the form of spirals; and if three or four of these are fixed at equidistant intervals upon the circumference of any part of the shaft, they will cause the bolt to advance so many times, while it will be compelled to recede after having been thrust up by the wiper, by the action of a spring properly disposed. On the contrary, when the motion is to be given to the bolt in the direction coinciding with the axis of the shaft (or parallel to it), the wipers are to be formed of double inclined planes, placed at equal distances about one of the ends of the shaft: the bolt being here also forced back by the action of a spring. The end of the bolt is recommended to be a little convex, or else a roller should be fixed into the bolt, upon which the inclined plane or curve works, in order, as far as may be, to diminish friction.

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*Observations.*—In Mr. Hancock's specification he has not pointed out the manner of construction of his wipers, though this is the only essential part of his improvement, and ought to have been explained minutely. It is well known to mathematicians that in one case the wipers must be either Archimedean spirals, or involutes of circles; and in the other case, the wedges must be bent into that shape, which would coincide with part of the thread of a screw, at least in the first half of them, the succeeding part being the inversion of the former. Indeed, we know not exactly what is the object of this patentee. Does he mean to secure to himself the right of converting rotatory into reciprocating motions in *any* way? This cannot be, because it has been done for centuries after various methods. Does he intend, then, to secure the right of performing this conversion by means of wipers? Yet this has no novelty in it; and if it had, he forfeits in great measure his title to the exclusive right, by neglecting to explain the mathematical construction of his wipers. After the expiration of Mr. Hancock's term, the public must investigate for themselves the construction of his wipers; and if that be the case, we believe the law will not prevent them from investigating them, and applying the results of their own investigations, now. We do not recommend this, however; for we have many doubts whether any great advantages would result from the application of the wipers. The chief advantage seems to be, the getting quit of the friction of the screw; but when the machinery is worked by a winch handle, this might be more than counterbalanced by having the greatest pressure in positions where the person who worked the winch could exert least force. The alternate motion, on the contrary, may be easily converted into a motion like that of rowing, which is a very advantageous method of applying human muscular energy.

*Mr.* Stephen Clubb's *Patent for an improved Mangle. Dated September* 1805.—*Repert. Arts,* No. 45, *New Series.*

This newly-invented mangle is constituted chiefly of two hollow rollers, which may be conveniently about $2\frac{1}{2}$ feet long and 14 inches diameter. They are not complete cylinders, but have about a fourth of the curve surface of each cut off by a plane running parallel to the axis of the cylinder. These hollow rollers being fixed in a stout frame, with their axles parallel to each other, and at about 14 inches distance, if they be turned round until the flat parts of each are brought near together, they will leave a space of about 3 inches to receive a small roller of that diameter, on which the linen is to be wound. The flat part of the upper roller is made to open so as to receive the materials which are put in to make it sufficiently heavy. A toothed wheel is fixed at one end of the upper roller, about 2 inches larger in diameter than the roller itself; and an equal toothed wheel is fixed at the opposite end of the lower roller. A horizontal axle carrying two pinions is so fixed that these pinions work into the teeth of both wheels; so that motion may be given to the whole by a winch at one extremity of this latter axle. The gudgeons at both ends of the upper roller, and at both ends of the axle carrying the pinions, should be joined by the connecting rods, and the whole have room to rise and fall 3 or 4 inches when occasion requires. The small roller is fixed in the frame by a button, which turns over the centre or spindle of it: and on the other side of the frame, the end of the cloth which goes round the linen, winds up and down when the mangle is at work.

*Observations.*—The patentee states three advantages as peculiar to his mangle, the first of which is founded upon an erroneous notion of theory, and is therefore omitted; the two latter of these we are inclined to allow, and therefore state them below.

"As the weight is constantly upon the linen, from the time it is introduced into the mangle until delivered out, the mangling must certainly be executed faster than if the linen were to be worked off of one roller upon another, as in the mangles of the usual construction.

"The weight used in my mangle is little more than half the weight required in any other mangles, consequently a little more than half the labour or power employed in other mangles will be necessary to set mine to work."

*Mr.* Alexander Brodie's *Patent for his new Method of making Steam-engine Boilers, and Steam Boilers for other Purposes, &c. Dated May* 1805.—*Repert. Arts,* No. 45, *New Series.*

Mr. Brodie's boiler has four vertical sides, every opposite two of which are parallel, and its top is flat. It is cast of any convenient size, and the cast iron plates are made with flanges to any size that may be wanted for the boiler, and put together with rivets or screws and nuts and pasteboard between the plates; and, to prevent the boiler from giving way by the force of steam, there are several wrought iron stays fixed in the inside of the boiler. The boiler thus constructed stands upon *iron,* so that there is scarcely a quarter of an inch upon the bottom of it where the fire has not its full power. There are two fire-places, and the flue round is done with brick, according to the height and width that may be required. The flat top of the boiler is also covered with brick; except a man-hole of about 17 inches diameter.

*Mr.* B. R. Dodd's *Patent for various Improvements in the Construction of Fire-places, and adapting Stoves and Grates thereto. Dated April* 1805.—*Repert. Arts,* No. 45, *New Series.*

According to the author, these improvements consist in plane reflectors of polished iron placed near the grate; they are moveable, or made to slide horizontally in grooves, or on rollers, and have liberty to open at different angles and at various distances from the grate. They may be fixed vertically on hinges to the *back* of the fire-place; in a line with the back of the grate; or they may be united to the sides of the stove or grate. These reflectors may each be made either of one entire piece, or separated about the middle: they may also be so constructed as to slide into a recess formed in the wall, or to slide out, or turn completely round; so that either side may be presented to the fire, one side only being polished and the other japanned.

The object proposed by introducing these reflectors is to augment the warmth of the room without increasing the consumption of the fuel. On the first kindling of a fire the reflectors may advantageously be drawn forward at right angles to the stove or grate on each side, in which situation they will assist in producing a strong draught, and cause the speedy inflammation of the fuel in the grate. When this is effected they may be pushed about half way back, that the heat from the sides of the fire may, after impinging against them, be reflected into the room: but when the

fire has burnt clear, the reflectors should be thrown farther back, in a line with the back of the grate, for various manifest reasons.

Another invention mentioned in this specification is that of an *extinguisher*, being a metallic case in form of a hollow parallelopiped, of such magnitude as completely to enclose the stove with the fire: this when put on will exclude the air, and therefore put out the fire without removing the heated cinders, or creating any dust or trouble. This latter invention, however, though equally philosophic, seems of far less utility and advantage than the former.

*Observation.*—These grates and fire-places appear to us to offer considerable advantages in the construction of new houses, but cannot easily be adopted in houses already built.

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*Mr.* MATTHEW GREGSON'S *Patent for a Method of cleansing Feathers, Hair, Wool, Down, &c. from their animal Dirt. Dated Dec.* 1804.—*Repert. Arts*, No. 45, *New Series.*

THIS method consists in enclosing the substances to be thus cleansed, in a chamber or vessel formed air-tight, in which they are disposed on sacks, or sticks, so as to be as little in contact as possible: heated air, or steam, is then made to pass through this chamber, which Mr. Gregson asserts will evaporate the animal oil when it is brought to the *proper degree* of temperature, and continued a *sufficient time*, neither of which he states.

The apparatus used for heating the air, or steam, and forcing it through the chamber, is not mentioned, but may be easily conceived.

*Observations.*—Oil being well known to be incapable of rising in vapour without a heat much greater than that of boiling water, we should imagine that steam would have little effect on it, unless raised to a temperature, and consequent pressure, which would require an apparatus like Papin's digester to contain it; indeed, the heat at which it evaporates is so great, that we think any feathers or hair must be destroyed on being exposed to it; we are therefore of opinion, that Mr. Gregson is deceived in thinking that the oil evaporates, and that the operation is effected by the evaporation of the water alone, which is attached to the oil by the mucilage contained abundantly in all animal oil, and that the oil and mucilage then form a dry pellicle or thin crust, on the parts of the feathers or hair where they exist.

But it is not so material to account for the effect of the operation as to be certain of its adequacy. If it actually deprives the matters submitted to it of all bad smell, it is very valuable; for by this mean the feathers of many sea-fowls may be rendered fit

for bedding, which, from the oil contained in them, were before useless, and which can be obtained in such plenty, as probably may in time lessen the price of this very necessary article.

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*Mr.* ALEX. WILSON's *Patent for certain Improvements applicable to Shot-belts, Powder-flasks, and Fire-arms of all Descriptions. Dated July* 1805.—*Repert. Arts,* No. 45, *New Series.*

IT is not in our power to give a perspicuous description of these improvements, without diagrams; we shall, therefore, only state, nearly in the words of the patentee, the chief advantages expected to result from his inventions. His improved breechings or plugs have an interior metallic touch-hole, placed in a peculiar manner behind the centre of the charge, projecting into the chamber in the form of a cone, and thereby preventing the shot from lodging, so as to make the gun miss or hang fire; the touch-hole also communicates with the powder in the pan through the ante-chamber, which is so constructed, that in damp weather the gun cannot miss or hang fire. The inside of the breeching, which contains the charge, is nearly of the shape of an egg, and so constructed as to permit the powder to remain always loose. It is easier cleaned, and has the advantage of inflaming the powder much quicker than any breeching previously used. The locks of a double gun are nearer together than any hitherto made, which renders it more convenient to cock the left lock. The exterior part of the breeching being sloped in an obtuse direction conducts the eye quicker to the object, and makes the priming in the pan tend more to the ante-chamber.

The jaws of the cock hold the flint in an oblique direction, which gives it more friction, increases the quantity of fire, and throws it close up to the touch-hole. The web of the pan is rounded, which prevents the powder from lodging, so as to disjoint the hammers. The pan is easier cleaned, the priming always kept dry, and the pan not liable to lose it.

The *rest* for rifles does not exceed two inches in length, and an ounce in weight; and may be used standing, or in any other position. A very heavy gun may be elevated or depressed with one hand, at pleasure, and at the same time kept perfectly steady.

The head of the shot-belt is so constructed as to contain various quantities of shot; is filled with accuracy without loss of time or hazard in spilling, and always contains a charge ready for loading. A similar improvement is made in the powder-flask.

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*Observations.*—It appears from Mr. Wilson's specification, and is, indeed, remarked by himself in some supplementary observations in the *Repertory of Arts,* &c. that, in loading, his guns prime themselves, owing to the close connexion of the touch-hole with

the ante-chamber. Secondly, The powder-flask is made to contain the same quantity of powder as the chamber of the gun, which brings the powder into close contact with the wadding or shot, and prevents the air from so lodging as to diminish the effect of the powder. Thirdly, In loading a double gun on the old method of construction, pallets of shot are apt to fall into the cylindric hole of the breech of the unloaded barrel, and stop the communication between the powder in the pan and the charge, which is with great difficulty removed. Double guns of Mr. Wilson's construction have this inconvenience completely obviated, by having the interior touch-hole elevated conically in the bottom of the chamber, which wholly prevents the pallets from lodging on it.

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*Mr.* A. O. Stansbury's *Patent for Locks and Keys upon an improved Construction. Dated May* 1805.—*Repert. Arts,* No. 46, *New Series.*

The principal objects Mr. Stansbury kept in view in this invention, are security, simplicity, and strength, which comprize all that is valuable in a lock. The principle of strength is, that of pinning or nailing two plates of metal while their surfaces are held in contact. For security, these nails or pins are made of such infinite variety, from their position and number, as to admit of any required number of locks without having two alike. In addition to this, the patentee multiplies the varieties of position and number by every change in the thickness of the moveable plate; and as a farther source of variety, the pins may be cut into unequal parts, by which means they will require to be pressed to different depths from the point of bisection in order to release the moveable plate. A similar variety is produced by having grooves in the moveable plate, and corresponding raised parts on the fixed plate, so that the extent of changes afforded by a combination of these varieties becomes absolutely incalculable. In order effectually to prevent the opening of the lock by any thing but its own key, the nails or pins may be placed out of sight, and guarded from access by the projecting stud of the lock on which the key turns; and as a security against the taking of an impression of the pins or nails by the insertion of a soft substance, or blank key, &c. a number of marks are made on the surface of the moveable plate, exactly similar to those caused by the ends of the pins entering through it. These pins admit likewise of being made of various sizes, some of them being extremely small, thus making it nearly impossible to contrive a false key even from the nicest inspection of the real one. Thus the difficulty of ascertaining the number and position of the nails is alone sufficiently great, without resorting to any variation of their relative lengths.

The pins or nails entering through the fixed plate are thrown by springs into the moveable plate, and the business of the key is to push them back by corresponding points fixed in it, so as to release and turn the moveable plate without entering the fixed plate; for were this the case, these points on the key would act as nails from the moveable into the fixed plate, and effectually prevent the release of the bolt. Either the bolt may be made separate from the moveable plate, and so moved by teeth, or the plate itself may constitute the bolt or fastening. Any required number of bolts may also be thrown in different directions at the same time by means of their connexion with the moving plate; or the plate itself may be made of such a form as to throw out points in every direction, when turned by the key.

In door-locks, where a catch or latch is required, and which, in the ordinary construction, is released by turning a knob or handle, Mr. Stansbury makes this knob to be pressed directly forward on one side, and pulled directly back on the other, according to the motion of the door, in order to open. This is effected by means of a chain or flexible substance, which, being pushed or drawn, draws back the catch, or releases the latch, and opens the door by the same motion. This pusher may either have a projecting piece acting upon the latch or catch-bolt as a wedge or inclined plane, or it may draw by means of a chain or flexible substance turning over a roller, or the action may be communicated by means of a crank or a wheel. A spiral spring is used to throw the latch or catch-bolt; and as this acts in a contrary direction to the motion of the pusher, a second spring may be added, to take upon the pusher and return it; this may be placed either inside of the lock, or within a hollow handle fastened to the door, through which handle the pusher moves. Thus, by drawing the handle with the fingers so as to hold the door while the thumb presses the pusher, the catch is released silently; on the opposite side it is only necessary to press the door with the thumb, while the pusher is drawn back by the fingers, to produce the same effect.

Instead of the small bolt generally used to fasten the door from within, Mr. S. makes the catch-bolt answer the purpose of stopping the action of the pusher with a button placed within the lock, and turning round the pusher: this button is connected to a plate or rim, likewise turning round the pusher in the room; and as the rim is moved, it turns a projecting part into a notch in the pusher, or under a pin from it. The catch-bolt likewise serves to increase the strength of the fastening, by causing the key-bolt, usually employed alone as a security to stop the return of the catch, which is thus incapable of being released until the other bolt be unlocked; so that the two together constitute one strong fastening.

In order to remove the inconvenience of a projecting box, which is commonly made to receive the bolt and catch of locks

placed on a door, and not mortised into it, the patentee makes the bolts with an elbow or bend, so as to shoot into the door-post from the middle of the door in the same manner as the bolt of a mortise lock. The same method is also applicable to drawer, desk, and other locks, where it may be used for greater security by causing the bolt to pass farther in; or the bolts may be made straight, and let into the door, which will be equally neat, and still stronger than a mortise lock.

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*Observations.*—Such is the general nature of Mr. Stansbury's proposed improvements: drawings to illustrate the minute parts of the constructions are given in the number of the Repertory of Arts, &c. mentioned at the head of this article. There is, it must be admitted, much ingenuity displayed in these contrivances, and they have the advantage of greatly diminishing the probability of picking a lock, by allowing considerable variety in the subordinate parts, while the same general principle of construction is retained: but as much nicety will be requisite in the mutual adjustment and adaptation of the parts, there will be the more danger that a derangement may soon take place, and the lock be thereby rendered useless. As to the apparatus intended to diminish the friction in working the catch-bolt, &c. there is much reason to fear that it will need frequent repairs, in consequence of constant use; and it is therefore not to be recommended. Various contrivances for the same purpose have been published in different volumes of the Transactions of the Society of Arts, which, in our opinion, are preferable to that proposed by Mr. Stansbury.

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*Mr.* Joseph Huddart's *Patent for Improvements in the Manufacture of Cables and Cordage. Dated October* 1805.—*Repert. Arts,* No. 46, *New Series.*

In the method of manufacturing cables and cordage, recited in Mr. Huddart's specification, the strands are wound on reels, placed in frames which turn round on axes, between two circular planes connected to a large spindle, or arbor, which receives its motion from the prime mover; the part of this arbor on which it revolves is formed hollow, to permit the strands from the reels to pass through, in which particular it resembles the spindle of the common spinning-wheel for flaxen thread; the frames of the reels receive a circular motion quicker than the circular planes in which their axes are fixed, and in a contrary direction to their motion, by being each connected with a fixed wheel, by a smaller intermediate wheel, which operates between it and a pinion fixed to the axis of the frame of the reel. The strands are drawn out from the reels by grooved rollers or *whirls,* which receive their motion from a fixed wheel on one of the circular planes in a similar manner to that

described, by which the frames of the reels receive their motion: the reels are prevented from moving too freely, by a contrivance which presses on their axes (which Mr. Huddart calls a *friction clutch)*, by which the friction is increased at pleasure by turning a screw; by this means the strands can only come off the reels as they are drawn by the grooved rollers: after the cable, or cord, has passed the cavity of the large arbor, it is moved onward between grooved rollers, or *whirls*, of a larger size, by which it is drawn off regularly, as it is completed, to the place where it is to be coiled up.

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*Observations.*—The principal advantage of this method of making cables or ropes is, that it admits of the work being performed in a small space, and thereby renders needless the great extent of ground, in length at least, necessary in the usual method of making ropes: but in this respect it has no advantage over the invention of Mr. William Chapman for the same purpose, for which he obtained a patent in January 1798 (vide Repert. Arts, vol. ix.). The chief difference between Mr. Huddart's plan and Mr. Chapman's is, that in Mr. Huddart's the twist of the cable is given by the whole machinery, or frame-work, which holds the strands, turning round. In Mr. Chapman's the twist is given by the coiled cable turning round, while the frames which contain the revolving reels of the strands remain stationary. The effect which this difference will occasion is, that, in Mr. Huddart's plan, the labour of turning the machinery will be greatest at first (when all the reels are fully loaded with the weight of the strands), and become gradually less as the weight of the strands on the reels is diminished by their being drawn off to form the cable. In Mr. Chapman's, the labour will be nearly equal through the whole process, as the mass in motion is increased in one part of the machinery in proportion as it is diminished in another part; this consideration at first view would seem to give an advantage to Mr. Huddart's plan; but it will not be found any in practice, for the same force will be requisite to turn the machinery of each in the beginning, and therefore an equal moving power must be provided for each; on which account the expense must be equal in this respect for both.

The saving in both plans, from their admitting of the work being performed in a small space, will be ultimately an advantage to the public as well as to the proprietors of them; for by the heavy rents of extensive rope-yards being removed from the manufacture, the articles in time can be afforded at a cheaper rate. We apprehend also, that ropes made in this manner will be twisted more equally in every part, as in the common method of rope-making, in which the twist is communicated through a great length of rope perpetually altering in its extent, an inequality of twist must necessarily ensue. Mr. Huddart candidly acknow-

ledges his having used several parts of Mr. Cartwright's patent rope-making engine in the formation of his own, which renders any remarks of ours on this head unnecessary.

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*Messrs.* Desormeaux *and* Hutching's *Patent for Improvements in the Manufacture of Candles. Dated October* 1805.—*Repert. Arts,* No. 46, *New Series.*

The improvement mentioned in the specification of this patent, consists in forming candles with an hollow cylindrical wick; the hollow wick, either previously woven, or formed by wrapping a flat wick round a thick wire, is together with the wire dipped in melted tallow, wax, or other materials, or else placed in moulds, and the materials poured round them: in some cases the passage at the bottom of the tubular wick is closed, and in others left open to admit a current of air; but in what those cases consist is not stated. It is also specified, that in some cases candles are made with external coats of wax or spermaceti, and the internal parts of tallow.

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*Observations.*—In September 1799 Mr. William Bolts obtained a patent for making hollow candles, which in some respects resemble those specified above. Mr. Bolts expressly mentions, that one species of the candles on his plan is to be formed with a tubular wick to admit air at both sides of it; and to have hollow glass cylinders applied outside the candles, similar to those used in Argand lamps, for increasing the light. (See Rep. Arts, vol. xii.) The principal difference between Mr. Bolts's invention and that under consideration is, that in Mr. Bolts's plan the wick is short, and contrived to descend as the tallow or wax consumes; in the latter the wick is formed the whole length of the candle. We do not apprehend, that where the hollow cylinder is closed these candles can have any material advantage over common candles, at least we could not perceive any in burning several of them in succession: if the tubes are left open to admit the air, unless they are of considerable size, or aided by a glass cylinder like Argand lamps, the air will not pass so as to occasion any advantage: this, at least, was the case with some of those with small tubes, which were tried with this view. If those with large tubes open to the air at their extremities, and furnished with cylindrical glasses, either did not melt too fast from the great heat this management would occasion, or could be prevented from doing so; there is no doubt that they would yield a much greater light for the tallow consumed than common candles: but we also apprehend that it would be attended with much trouble to snuff large cylindrical wicks without injuring the candles; and in this respect we think Mr. Bolts's invention superior, in which

the wick descends and burns like that of a lamp, without requiring to be snuffed. In making these hollow candles, it would be always expedient to cover the inside of the wick with a coat of tallow or other material, so as to exclude the air from the interior surface of the wick, from which it will otherwise imbibe so much moisture as to cause the candles to burn very unpleasantly.

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*Mr.* Thomas James Plucknet's *Patent for an Improvement to Capstans and Windlasses. Dated February* 1801.—*Repert. Arts,* No. 46, *New Series.*

If a rope is wound round any longitudinal body two or more turns, and the body turned on its axis, the turns of the rope will move on to one extremity of the body, where they will be stopped by the frame-work in which it turns. This makes it necessary, in order to continue the operation of winding, that the turns of the rope should either be driven back by force along the body to their first position, or that the tension of rope should be slackened, in order to admit of the same being done without force. In the common method of using capstans and windlasses, this operation is performed on the cable, or messenger, which they are employed to draw in, in general by slackening them (by reversing the motion), so as to admit of the turns being moved along the barrels of those engines; and sometimes the turns are forced back by the blows of heavy wooden malls.

The principal part of Mr. Plucknet's invention consists in a method of facilitating the latter method of moving the turns of the cable, or messenger, to their first position, by a force as regular and uniform as that of the operation of the mall is the reverse.

This is performed by a number of pieces of iron or brass, from twelve to eighteen inches long and two square, placed so in grooves or sockets as to move freely up and down on the face of the barrel of the capstan, between the whelps: the upper parts of those lifters are formed into heads of a proper shape to bear against the cable; the other extremity of each contains a friction-wheel, which rests on a circular inclined plane beneath the capstan, formed by a flat circular plane raised (a few inches) higher at one side than at the other: from this arrangement it is evident that each of the lifters, when the capstan is moved round, will in succession rise higher as its friction-wheel is rolled along from the lower to the higher part of the circular inclined plane, and again will descend by its weight as the capstan turns, till it comes to the lowest part of the inclined plane again.

By this contrivance the head of each of the lifters will press upwards the part of the turns of the cable, or messenger, directly over it, with a force proportionate to the angle of inclination of

the plane, which thus acts like a wedge of continued operation to force up those turns.

In adopting this contrivance to windlasses (in which, from their horizontal position, the weight of the lifters could not operate in bringing them to their first position), another friction-wheel is added to the side of each lifter, which acts against an upper inclined plane that only projects so far as the breadth of the wheel requires, and which is united to the lower plane.

The other part of Mr. Plucknet's contrivance, intended to facilitate the operation of *holding on*, consists of an upright cylinder, fixed as close to the capstan barrel as the thickness of the cable or messenger will admit, which, by pressing it against the barrel (which should be also cylindrical) as the capstan turns, employs the force used in turning the capstan for *holding on*, or keeping the turns tight on the barrel, instead of having hands purposely engaged for this design.

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*Observations.*—Mr. Plucknet's first invention is a very great improvement on the usual method of forcing the turns of the messenger along the barrel of the capstan, and is very useful in rendering unnecessary the method of effecting the same purpose by slackening the messenger, which is an extremely dangerous operation, when very heavy weights are in the act of being heaved up. When we say that it facilitates the operation of forcing up the turns of the cable or messenger, we do not mean to imply that it requires less force than the other method of effecting this purpose, but that it applies it in a more regular and uniform manner; the force to be overcome is the same in both cases; but the action of the inclined plane, or perpetual wedge, used by Mr. Plucknet, is much better, and much less injurious to the messenger or cable than the blows of the mall.

In both cases, however, an action very injurious to the cable or messenger must take place, in which its turns are forced up laterally along the capstan-barrel, while pressed round it by the great weight of a depending anchor, or perhaps some greater strain. It is evident, that in proportion as this pressure is great, so must the friction be great also of the turns against the barrel in moving upwards, and that the wear of the cable or messenger must be in proportion to this friction. This wear of the cable or messenger is the only matter of any consequence in the operation, the greater force requisite to move round the capstan, which this friction will occasion, being of very little importance, and amply compensated by the time saved in rendering surging useless.

Another method has been contrived for the same purpose by Captain Hamilton (see Rep. Arts, vol. ii. 2d series). This consists of a capstan formed with a conical barrel, of which the slides incline inwards very much, or, in other words, whose barrel consists of a very obtuse obtruncated cone; the great inclination

of the sides of this barrel forces the turns of the cable to rise as it turns round: but this method is no less liable to lateral friction, and to occasion great wear of the cable or messenger, than Mr. Plucknet's, and has also the inconvenience of occasioning the upper turns to become loose as they rise, as it is very evident the turn or round of the cable that will be tight on the lower and larger part of the barrel, must be loose when it resists a part an inch or two less in diameter.

It is imagined, if any of the lifters were broken at sea, or their wheels displaced, it would be difficult to repair them; but this might be facilitated by bringing out half a dozen spare lifters in case of accident.

We expect soon to see published another plan for this same purpose, which occasions no lateral friction whatsoever to the cable or messenger, and of course in which they will be much less liable to wear, and therefore last longer than in any other method yet used, and which is so easily made, that it can be formed by any ship-carpenter: if we had not known of this improvement, we might have been led to suppose that the lateral friction in this operation was as unsurmountable as the resistance occasioned by the bending of the cable or messenger in its coiling round the capstan, and have therefore been as silent on the one head as the other: but knowing as we do of the possibility of removing this disadvantage, Mr. Plucknet will excuse us for mentioning it, as our object is to communicate whatever useful information comes to our knowledge on any subject we bring before the public. But while we say we know of a better engine for the same purpose than Mr. Plucknet's, we at the same time willingly give his that commendation for ingenuity and happy effect, which it so well deserves.

The second contrivance of Mr. Plucknet to facilitate holding on, will so far effect that purpose, that a small additional force at the capstan-bars will enable the force employed for holding on to be greatly diminished at least, if not entirely dispensed with.

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# AGRICULTURE.

*On the Food of Plants. By the Rev.* Joseph Townsend.—*Bath Papers*, vol. x.

The experiments here recorded were made in 1796 and 1797. Four garden-pots were filled, wholly or in part, with clean-washed quartz sand as follows: No. 1 without any addition; No. 2 was manured with woollen rags, chopped small; No. 3

with $\frac{1}{4}$th part of charcoal in powder: and No. 4 with $\frac{1}{20}$th part of lime. Five other pots were filled in like manner with brick-makers clay; No. 5 without any addition; No. 6 with a $\frac{1}{2}$ part of quartz sand; No. 7 with $\frac{1}{4}$th part of charcoal in powder; No. 8 with bits of woollen rags; and No. 9 with $\frac{1}{20}$th part of lime; No. 10 was quartz sand, and dung from the bowels of a horse; No. 11 peat-earth. On the 12th of July 1796, a healthy cabbage plant, weighing $\frac{1}{4}$ of an ounce troy, was planted in each of the above 11 pots, and a similar one, No. 12, was at the same time planted in the garden, in rich mould, with the same exposure as the pots; each of which was placed in pans, supplied from time to time with water, until the 12th of January 1797, when the plants were taken out of the pots and weighed. The plant of No. 1 was found to weigh only $\frac{1}{4}$ of an ounce, as at first; No. 2 weighed 2 oz.; No. 3, $\frac{3}{4}$ of an ounce; No. 4 only 3 dwts. having lost $\frac{2}{3}$ths of its original weight, although it kept alive; No. 5, $\frac{1}{2}$ an ounce; No. 6, $\frac{1}{2}$ an ounce; No. 7, $\frac{1}{2}$ an ounce; No. 8, 4 ounces; No. 9 never advanced in growth, but died in December; No. 10, $4\frac{1}{2}$ ounces; No. 11, $\frac{1}{2}$ an ounce, the root being rotted off; and No. 12, 4 ounces. It is remarked, that although the rags in No. 2 appeared to have had considerable effect in increasing the growth of the cabbage plant, yet at the end of this experiment they were found not visibly decayed.

The earth being returned into each pot, a grain of wheat was on the same day sown in each, all of which grew; water was supplied in the pans as above, and on the 25th of September following No. 1 was found to have 2 wheat-stems 23 inches high, and the ears thereon to be $1\frac{3}{4}$ inch long; No. 2, 4 stems 28 inches high, and the ears $2\frac{1}{2}$ inches long; No. 2, 1 stem 18 inches high, and the ears $1\frac{3}{4}$ inch long; No. 4, 2 stems 21 inches high, and the ears 2 inches; No. 5, 3 stems 27 inches high, and the ears $1\frac{3}{4}$ inch long; No. 6, 4 stems 25 inches high, and the ears $2\frac{1}{2}$ inches long; No. 7, 4 stems 24 inches high, and the ears 2 inches long; No. 8, 12 stems 33 inches high, and the ears $2\frac{1}{2}$ inches long; No. 9. 1 slender stem 15 inches high, and the ear $1\frac{3}{4}$ inch long; No. 10, 16 strong stems 37 inches high, and the ears $2\frac{3}{4}$ inches long; and No. 11, 6 stems 35 inches high, and the ears $2\frac{1}{4}$ inches long. Mr. T. remarks, that the result of No. 1 in both the experiments shews, that water alone can produce in this climate but a small effect, although in hot climates plants growing in nearly clean sand, well watered, have been found to flourish luxuriantly, and come to great perfection. The effect of carbon, though not strikingly apparent in the growth of cabbages or wheat in Nos. 3 and 7, is inferred by Mr. T. from the chemical analysis of vegetables, several of which he enumerates as containing a large portion of carbon in their composition; and some few others, in which a very small portion is found. The powerful effect of animal manure is noted in the results of

No. 10; and the benefit from rags in the second experiment, Nos. 2 and 8, although, at the conclusion of the second experiment, the rags were found still to retain their texture; and it is observed, that 4 or 5 cwt. of woollen rags, chopped small and spread on an acre of wheat, have repeatedly been found nearly to double the crop, and visibly to increase the two succeeding crops. The detrimental effect of lime in Nos. 4 and 9, is not ascribed by Mr. T. to any deleterious property therein, as the plants all lived a considerable time, but to its action as a cement, in forming a crust on the surface of the pots impervious to air; for in these pots he remarked after rain, that the water stagnated, and did not readily penetrate, as in the other pots: this is compared with the running or binding of certain soils in case of rain after sowing, or to the baking of the surface of garden pots, if watered in the heat of the sun, in a time of drought and great heat, whereby the air is hurtfully excluded from the seeds or roots of the plants; and the well-known advantage of stirring the spaces between plants, by hoeing or otherwise, is also adduced, to shew the advantage of a free transmission of air to the roots of plants.

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*Experiments on the Effect of certain Substances applied as Manures, By Mr.* Arthur Young.—*Ann. Agric.* No. 258.

We particularly noticed, at page 118 of our first volume, the former labours of this gentleman on the subject of manures. He has since published the details of several considerable sets of experiments on different substances and mixtures, used as manures to garden-pots and small vessels: in the first set, 23 pots were filled with loam and sown with large German turnip-seed on the 14th July 1804; and different manures were applied, by watering with the same from time to time, from as many bottles, in which water was mixed and shook up with pearl-ash and charcoal, pearl-ash, charcoal, charcoal and quick-lime, pearl-ash and stone-blue, charcoal and chalk, charcoal and cream of tartar, charcoal and magnesia, charcoal and calcined magnesia, salt of tartar, indigo, water only, vitriolated tartar, Epsom salts, green vitriol, pearl-ash and spirit of nitre, soda and spirit of nitre, clipt straw, Glauber's salts, and charcoal with pearl-ash and salt; besides which, ground malt, malt-dust, and barley-meal were used dry, and mixed with the loam. On the 13th of August, the malt-dust seemed to have by far the best effect; the Epsom salt, charcoal, Glauber's salts, charcoal with pearl-ash and salt, and indigo appeared successful, in the above order; while pearl-ash and stone-blue, ground malt, and barley-meal were the worst. The turnip-plants being removed, and 3 grains of wheat sown in each pot, on the 8th of October, and the manured or simple waterings continued as before; on the 5th of July, ground malt seemed to have had the

best effect, and next indigo, water, barley-meal, Glauber's salts, and straw in this order; while the pots watered with pearl-ash and stone-blue, charcoal and chalk, salt of tartar, and pearl-ash with spirits of nitre, were without any vegetation. In another pot with loam, it was contrived to throw up daily a portion of inflammable air, produced by dilute sulphuric acid and iron filings, in a bottle fixed under the pot; some of the gas passed through the loam, as was evident by its smell on the surface, and the growth of the turnip-plants therein was surprisingly luxuriant. Gum arabic and spirits of wine, spirits of nitre with sulphuric acid and pearl-ash, and charcoal with pearl-ash, salts and spirits of nitre, were also tried, as ingredients in the liquid manures for pots of loam. On the 19th of July 1804 another set of experiments was begun by Mr. Young; into each of 24 tumblers, 5 ounce measures of water from a pond, on a calcareous soil, were put; and upon the surface in each, a thin cork floated, having a small cavity in its centre; three turnip-seeds wrapped in cotton were placed in each of these cavities, after various substances had been added to the water in the different glasses, viz. Glauber's salts, Epsom salts, salt of tartar, vitriolated tartar, pearl-ash, red lead, cream of tartar, green vitriol, stone-blue, indigo, pearl-ash and charcoal, charcoal, gum arabic, spirits of salt, spirits of nitre, sulphuric acid, spirits of wine, ditto only 6 drops, chalk, loam from fleg, rich gypsum, Bagshot Heath soil, and salt; the remaining tumbler had water only: these were placed together in a window fronting the north; the plants were inspected five times previous to the 30th of July to note the order of their vegetating; on that day the gypsum plants were found considerably the best of all; the Glauber's salts, and the charcoal, were next, and nearly equal; the indigo, vitriolated tartar, red lead, chalk, and the water alone, were grown nearly in the above order. On the 5th of August, the order of their appearance in goodness was as follows: fleg-loam, gypsum, indigo, charcoal, Glauber's salts, red lead, and vitriolated tartar. On the 28th of August the order appeared as follows: gypsum, fleg-loam, charcoal, Glauber's salts, vitriolated tartar, red lead, and water alone. October 8th, the indigo appeared by far the best, and gypsum, fleg-loam, charcoal, vitriolated tartar, red lead, and chalk, were next in order: the turnip-plants were now removed, and on the 15th of October a grain of wheat was deposited in each cork. On the 7th of November the Epsom salts had a plant $\frac{1}{4}$ of an inch high, salt of tartar $\frac{1}{2}$ an inch, red lead 2 inches, green vitriol $1\frac{3}{4}$ inches, indigo $\frac{3}{4}$ of an inch, gum arabic $1\frac{1}{2}$ inch, gypsum $1\frac{1}{2}$ inch, and salts $\frac{1}{8}$th of an inch: none of the others had vegetated. In another set of experiments 21 tin canisters, containing one pound of loam each, and a portion of the following substances, viz. Eaton-Socon loam, fleg-loam, spirits of wine, pearl-ash with salt and charcoal, salt and pearl-ash, salt and charcoal, pearl-ash and charcoal, pearl-

ash and spirit of nitre, salt, chandler's graves, gypsum, spirits of hartshorn, vitriolated tartar, malt-dust, nitre, and pearl-ash; some seeds were on the 20th of July deposited in each (turnips we suppose, but of this the worthy secretary has omitted to inform us). On the 7th of August the pearl-ash plants were by far the best; the Eaton loam, charcoal and pearl-ash, loam alone, gypsum and vitriolated tartar, were found good, and in this order: the plants being removed, a grain of wheat was sowed in each, on the 29th of September; and, on the 4th of July following, the canister manured with malt-dust was found to have by far the best plant: the fleg-loam, spirits of hartshorn, Eaton loam, loam alone, spirits of hartshorn, salt and charcoal and spirits of wine (a spoonful), were good, in this order. With a view to try the effects of indigo with more precision, 5 tumblers were provided, each with 6 ounce measures of pond-water, from a clayey bottom; these were provided with floating corks as before, and a single grain of wheat in each, on the 15th of August: No. 1 was without addition; No. 2 had 15 grains of indigo added; No. 3, 30 grains of ditto; No. 4, 40 grains of ditto; and No. 5, 30 grains of indigo and 5 of pearl-ash: between the 30th and 31st of August, the thermometer being at 80° in the hottest time of the day, the plant in No. 4 *increased a full inch in height in* 24 *hours!* On the 8th of October No. 1 had attained $2\frac{3}{4}$ inches in height, but was in a bad state; No. 2 was 7 inches high and green; No. 3 was $8\frac{1}{2}$ inches high, but not so healthy as the last; No. 4 was $9\frac{1}{2}$ inches high, but sickly: No. 5 was 5 inches high, and in a bad state. On the 22d of August 1804, 12 tumblers were provided with corks, and a grain of wheat stuck in each; 5 ounces of pond-water were poured into each, and different substances added as follows, viz. brick-dust and salt, brick-dust, charcoal, clayed sugar, charcoal and pearl-ash, pearl-ash and spirits of nitre, spirits of wine, spirits of wine and pearl-ash, spirits of hartshorn, indigo, and indigo and pearl-ash. On the 8th of October, the grain where the indigo had been used was found 14 inches high, the brick-dust and salt 11 inches high, the charcoal 7 inches high: all the others appeared to fail.

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*On Dung and Manures. By Mr.* Vertue, *Mr.* Wade, *&c.*

The experience and practice of Mr. Vertue, a Suffolk farmer, are detailed by Mr. Young in No. 258 of his Annals: from long experience, Mr. V. has rejected the practice of throwing up his yard dung into dunghills, and turning the same until it be rotten, by which he says, that its quantity is so amazingly diminished that four loads of long dung, in the state which he prefers to use it, will make only one load of rotten dung, as generally used, and that the escape of the gases and other matters occasioning this diminution, might and ought to have been caught and retained in

the soil, if the fresh dung had been ploughed into the same. Mr. V. is of opinion, that it is to the increased quantity of manure thus applied to his land, and the increase of straw to make it, from more crops, that he has succeeded in omitting fallows, and pursuing the drilling system, under which his land is become clean, and is increasing in fertility; he considers straw as of too much value to be *eaten* by lean stock, but raises potatoes for fattening of oxen, and keeps his horses on green clover, each well littered with straw, which they manure and tread into dung: across the lower part of Mr. V.'s yard, where the soil was lighter, a wall of clay has been formed to prevent the escape of the urine and moisture of the manure: twelve loads of dung taken immediately from the yard, Mr. V. finds sufficient for an acre, while his neighbours are using fifteen or sixteen of rotted dung, or twenty of compost.

The practice of Mr. Wade, another Suffolk farmer, is stated by Mr. Young in the same number, to be the same as to the use of long dung, a practice which Mr. Y. has throughout recommended in his Bedfordean Essay on Manures in the Bath Papers, vol. x.

A correspondent, T. S. S. in the Farmer's Magazine, No. 25, has enforced the advantages of feeding cattle in the yard with turnips, clover, tares, &c. for converting the straw into dung; he proposes a little earth or mould to be mixed with the dunghill, as it is formed to check the excess of fermentation, in which some of the best principles of the manure escape: he also recommends a littered yard to be provided in or near a turnip-field for the sheep to lie in, and thereby convert a quantity of straw to valuable dung while they are eating off the turnips.

Vraic, a sea weed, is described by a gentleman of the island of Jersey, in the Bath Papers, vol. x. as much in use there for manure; it is cut shortly after Midsummer from the rocks, brought on shore, and spread, dried, and stacked like hay: the dried vraic is afterwards burnt in a chimney, and the ashes are used as a manure, at the rate of forty-eight bushels to the vergee (two and a quarter of which make an English acre). In some parts of the island this weed is gathered in February and March, and spread green on the land, at the rate of two cart-loads, or sixteen horse-loads to the vergee.

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## *On Marling and Warping. By Mr.* A. Young.

It is the practice of the Earl of Albemarle, whose farm in Suffolk is described in Young's Annals, No. 258, to let his marling-work at eight-pence per cubic yard, to a person who keeps ten horses employed throughout the year (carrying fifty yards a day on the average), who, besides his own horses and carts, pays for all labour; seventy cubic yards are laid per acre upon the clover lays; and this is done from twelve to eighteen months be-

fore breaking them up, that the weather and repeated harrowings may completely and evenly incorporate the marl with the soil before ploughing.

Mr. Young informs us (Annals, No. 258), that the essential improvement of warping, so largely practised on the borders of the Trent and other muddy rivers, is not practised in the neighbourhood of Lynn, although about twenty years ago a gentleman successfully tried it near Denver's Sluice on the Great Ouze river, by letting in the water when the river was very muddy, and confining the same upon his land by temporary banks until it had become clear, and then returning it to the river by his draining or fen mill, and letting in a fresh portion of thick water, to be returned in like manner, until the successive deposits had raised the surface of his land above two feet, with a most fruitful and rich soil.

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*On paring and burning Soil. By Mr.* Page *and Mr.* Parsons.

Mr. Arthur Young, the great champion for this practice, has succeeded in proving completely the great temporary benefit which may be obtained from it. In No. 258, p. 302, the successful paring and burning of three hundred acres at Cobham, in Surry, by Mr. Page, at the expense of forty-two shillings per acre, is described.

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*Observations.*—Practical and well-informed agriculturists were never at issue with Mr. Young on the propriety of *once* burning rough and coarse pastures or commons, intended to be broke up, *and judiciously managed afterwards*; but gentlemen of landed property, and attentive agents to such, have ever, and it is hoped always will be careful, to guard against the general introduction of *a paring and burning system*, as practised by many in the fens; the incomparably deep and rich soil of which is alone able to bear it, without absolute and almost irretrievable ruin. The practice we allude to is, after paring and burning, to take as many crops of wheat, barley, or oats, in immediate succession, as the land will bear, and then, generally without any cleaning, to sow a few seeds, but which is often unnecessary from the quantity of weeds in the soil, and to let it rest, generally with impatience on the part of the occupier, until sward enough is formed to repeat the burning and successive cropping as before! When farmers in general shall have adopted, and invariably act upon the great maxim, of taking *only one white crop* in immediate succession, and pay proper attention to cleaning their land, and resting it at proper intervals in seeds, landlords will find no difficulty in permitting paring and burning in most instances where lands are to be broke up; but until these can be readily accomplished, either by the voluntary acts of the tenant, or by effective agreements or

leases, landlords, who have a proper regard to their own or the public interest, will continue to restrain an indiscriminate paring and burning, whatever the sanguine friends of that system of management may urge to the contrary.

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Among the Bath Papers, vol. x. p. 234, the practice of Mr. White Parsons, of Somersetshire, is commended, in burning the clay thrown out from the ditches and trenches made for improving his farm: this clay was burnt in heaps of three or four hundred cart-loads; and when the ashes were used alone, forty cart-loads were spread on an acre; but generally the calcined clay was mixed with coal-ashes, lime, sand, gravel, or road-dirt, to form a compost. Mr. Parsons states, that a cart-load (fifty bushels) of these ashes from clay cost but two-pence burning, and are found much better than marl for strong land, and will be cheaper than lime in many situations.

*Observations.*—Mr. Nicholas Buckley, of Normanton in Nottinghamshire, has, we understand, long, and perhaps more largely than any other person, practised the burning of clay, by which he has most astonishingly improved his estate. In many situations clay, sufficiently mixed with useless coal, may be dug on the outcrops of coal strata to burn at once without other fuel; and in many other places dried peats might be mixed with lumps of clay in large stacks, and burnt as a manure.

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## *On Salt as a Manure. By Mr.* Wade *and Mr.* Carpenter.

Mr. Wade has, in the Annals of Agriculture, No. 258, related his experiments of sowing salt upon turnips after the plants were up, in two instances, without its proving at all beneficial; in another, he marked seven separate square rods in a field where a barley crop was just come up: the first three he watered with one, two, and three watering-pots full of sea-water respectively, but no visible effect was produced thereby; the fourth rod, that had four pots full, was injured thereby; the fifth, with five pots, was more injured; and on the remaining two rods, that had six and seven pots full of sea-water respectively, the barley was entirely killed. It is to be lamented, that Mr. W. has omitted to tell us how much his watering-pot held; nor has he (as observed in our first volume, p. 283, on another occasion) informed us whether his soil was a *dry* or *moist* one, a thing particularly to be noted in experiments of this kind.

Mr. J. Carpenter states, Agr. Mag. No. 77, that he had a rough close of ten acres covered with tall rushes, which he first mowed close to the ground, and then dressed the same with a compost of mud and soil from the banks of an adjoining brook, mixed with six or seven waggon-loads of offal salt; next year, white

clover, cow-grass, and the yellow vetch, intermixed with fine grass, covered the close, and the pasture continued excellent for several years: this might have appeared a case of the application of salt to a *moist* soil, had not Mr. C. added that the water did not lie deep, which occasioned the growth of the rushes on this field, and was drawn off by a deep ditch made on one side of the same, at the time of applying the salt compost.

Salt is stated, in the Agricultural Magazine, No. 78, to have rendered barren apple-trees, in an orchard belonging to Mr. Gilbert, the late Duke of Bridgewater's agent, highly productive of fruit, by being spread on the ground round each tree at a distance from the trunks.

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*Description of a Plough that will turn the Furrow on either Side; by Mr.* GRAY. *And on Ploughing, Tillage, &c. by Mr.* YOUNG, *Mr.* BRIGHTLEY, *&c.*

IN the Farmer's Magazine, No. 25, Mr. Andrew Gray has given a drawing and description of a turn-rise plough: the two mould-boards are fixed to the sole, making the proper angle with the same and one another; the mould-boards and sole turn on a vertical pin firmly fixed in the beam, a few inches from the front or meeting of the boards; and an iron stay, between the hinder and upper corners of the mould-boards, formed into an arc of a circle, slides through a staple in the beam, by which the mould-boards are steadied: there are two coulters, one on each side of the beam, to be used alternately; these turn on a pin fixed in the beam, and when not in use, are turned up so as to lie against the side of the beam out of the way: on the top of the beam there is a long lever, moving horizontally on a pin fixed in the beam near its centre, its fore end is connected with the whipple-tree chain, and moves the same to the right or left, according as the furrow is to be turned to the right or left: another horizontal lever is provided, connected with the former, with the circular mould-board iron, and with rods connected with the two coulters, so that the ploughman, by simply moving its hinder end (which is before him between the stilts or handles of the plough), the system of levers with which it connects, at once moves the mould-boards into the proper position, lets down the proper coulter to act, raises the other out of the way, and shifts the whipple-tree chain to suit the line of draft; two notches are provided in a cross bar between the stilts, from one to the other of which the ploughman shifts his lever alternately, and the notch prevents the levers from moving, until a furrow is completed, and they required to be shifted to perform the next.

Mr. Young (Ann. No. 258) has described the practice of Mr. Vertue, as decisive in favour of drilling and horse-hoeing, well

conducted, over fallowing, as a mean of cleaning, or rather keeping of land clean. Mr. V. always ploughs his headlands first, and again when the ploughing of the field is finished, to compensate for the treading of the horses in turning every bout upon them. Mr. V. is averse to ploughing of strong land in the spring, before sowing of Lent corn, and says, " When the winter's frosts have pulverized the surface, and brought it into that temper which receives rain, and does not plaister or bind with it, but on the contrary dries, and resumes its former porous state, if this surface be turned down by the plough, nothing equal to it as a matrix for the seed can again be expected. The farmer is at the mercy of every dash of rain, and every drying wind; he has mire or clods to deal with, and his season often lost." Mr. V. ploughs for the drill in autumn, and in the spring only scarifies, by horses walking in the furrows, and then drills his seed. The practice of Mr. Wade (Annals, 258) in not ploughing his strong land in the spring, accords with the above.

Mr. James Brightley, in the Agricultural Magazine, No. 79, has recapitulated most of the arguments used in favour of autumn and spring ploughing, by their respective advocates, but has omitted one in favour of the latter practice, which, if not often avowed, we have known sometimes urged, and believe it very often acted on, by slovenly farmers, viz. that leaving their land whole during the autumn and winter, enables pigeons, rooks, and the smaller birds, to pick up a large portion of the seeds of weeds, which ploughing immediately after harvest would have buried, to produce a crop when future stirrings shall have brought them near enough to the surface: and, that the seeds of many weeds, charlock (*sinapis arvensis*) for instance, can be preserved for any length of time in the soil.

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## *On Draining. By Mr.* A. Young.

In order to shew the vast importance of the drainage of the fen lands on the eastern side of this island, Mr. Arthur Young (Annals, No. 258) has given several interesting particulars and calculations, from which it appears, that from 300,000 acres of such land, a produce of nearly one million sterling value is annually reaped, even with the present imperfect drainage! In our last number (vol. i. p. 278) we had occasion to notice a proposal for applying the power of steam-engines to the drainage of these fens. On the present occasion, Mr. Young has inserted two letters from the Rev. Edward Cartwright: the first of these letters states, that " An engine of the price of 180*l.* (called a three-horse power) would clear 1000 acres (supposing the water one foot deep) in fourteen days, going night and day. The consump-

tion of coal, provided it be of the best quality, and carefully managed, would not exceed four bushels in twenty-four hours."

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*Observations.*—As we think this calculation, coming from such authority, likely to do considerable mischief, it is our duty to endeavour to elucidate the matter; thus, 1000 acres multiplied by 43,560 superficial feet in each acre, and this by one foot the depth of water, and this again by 62½ pounds in each cubic foot of water, gives 2,722,500,000 pounds, the weight of water to be cleared from off the land. Now as this can, it is said, be raised in 14 days by the consumption of four bushels of coals per day, or 56 bushels in the whole, we have to divide the above number of pounds by 56, and the quotient will be found 48,616,071 pounds of water, raised by the consumption of each bushel of coals. The height to which this water must be raised, is next to be considered; and, from the second letter above alluded to, we find, that 6 feet is the height of bank over which this quantity of water (standing at first one foot deep) is calculated to be raised. But we are to consider, that 84 days is mentioned (page 280) as the time necessary for emptying 6 feet depth of water over the same bank, while 14 days (or $\frac{1}{6}$th part thereof) is allowed (page 279) for *one* foot of depth: from which it is plain, that this mechanic considers all the water, both in 6 feet and 1 foot depth, as lifted *the whole height* or depth, viz. 6 feet: but engineers well know, that the power required to empty water, out of a full vessel or reservoir over its side, is equivalent to lifting the whole weight, only *half the depth:* the height for calculation in this case is therefore 5 feet to the surface of the water, and ½ a foot within the same, or 5½ feet for the whole of the water 1 foot deep. And since 48,616,071 lbs. is, as above, lifted 5½ feet by one bushel of coals, this is equivalent to lifting 5½ times that weight, to the height of only 1 foot, that is, $48,616,071 \times 5\frac{1}{2} = 267,388,390$ lbs. or $267\frac{1}{3}$ *million pounds is estimated to be lifted* 1 *foot high by the consumption of a single bushel of coals!* Messrs. Boulton and Watt (whose engines will certainly bear an advantageous comparison with any of this mechanic's engines, whether at Wisbeach, Woburn Park, or elsewhere) only engage to raise (see Encyclopædia Britannica, Sup. 3d edit. vol. ii. p. 524) 30 *million pounds* 1 *foot high*; and this, we believe, has very rarely been realized, even by the best of their engines, and when these were in the most perfect order; yet, this is but very little more than $\frac{1}{9}$th part of what these new engines are here said to be capable of performing! If we had, according to this mechanic's method, taken 6 feet as the height of lifting (instead of 5½ as above), the effect would have appeared 9¾ times what Mr. Watt's engines do!! We cannot refrain from remarking, that if Mr. Young believed that *for* 180*l. as the whole expense, except brick-work,* an engine nin

times as efficacious as the best ever before in use could be erected, he ought not for 5½ years (these letters are dated in July 1800) to have delayed to publish information so highly important; and supposing Mr. Y. to have known the fallacy of the statements in these letters, why at this late period publish them at all?

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*On the Cultivation of the Poppy. By* J. Cogan, *M. D.—Bath Papers,* vol. x.

The principal object of this Essay seems to be to prove that the expressed or cold-drawn oil of poppies is nearly equal to, and hardly discernible from, olive oil, for the table and other uses; and that the same does not in any degree partake of the narcotic or stupifying quality of its capsule or seed-pod, which property is found to reside only in the outer rind of the pod; and an experiment is related, of obtaining opium from the lacerated capsules of a crop of poppies, and afterwards perfect seed from the same. The culture and management of this plant and its seed are detailed under the heads of *soil,* kind and quantity of *seed,* time of *sowing, weeding, harvesting,* expressing the *oil,* both cold-drawn and by heat, *expenses, produce,* and *profit.* The statements under the last head are not very flattering; yet there may be situations and circumstances where the occasional culture of this seed in the British islands would prove advantageous; the cakes having been found useful in the feeding of cattle in Brabant, where the seed is largely cultivated.

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*** *We think it proper to acquaint our readers, that the period which our present Number embraces has been very fruitful of subjects, the whole of which, agreeably to the plan of our work, ought to have been introduced; and although we have given in this Number an additional half-sheet, we have been reluctantly compelled to defer noticing some few matters till our next.*

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ERRATA.

Page 37, line 19, *for* Phil. Journ. No. 49, *read,* 51.
42, — 28, *for* rules, *read,* rulers.
43, — 6 from bottom, *after* with, *add,* spar.
44, — 21, *for* succe-sively, *read,* successfully.

# RETROSPECT

OF

# PHILOSOPHICAL, MECHANICAL, CHEMICAL AND AGRICULTURAL DISCOVERIES.

No. V.] *April, May, June.* [1806.

## NATURAL PHILOSOPHY, ARTS, AND MANUFACTURES.

*Abstract of a Memoir on the Theory of capillary Tubes. By M.* LAPLACE.—*Journal de Physique, tome 62.*

LAPLACE has examined anew the difficult points of this theory. Clairaut was the first who subjected it to an exact and rigorous analysis; but his theory leaves us still in need of a complete explication of the principle of the phenomena, which consists in this, that *the elevation of the fluid above its level, in tubes of the same matter, is in the inverse ratio of their diameters.*

The new researches of Laplace shew that all the laws in which the attraction ceases to be sensible at a perceptible distance, give the elevation of the fluid in the inverse ratio of the diameter of the tubes. Clairaut supposed that the action of the capillary tube is sensible upon the infinitely narrow column of the fluid, which passes through the axis of the tube. Laplace, on the contrary, thinks with Hauksbee and many other philosophers, *that the capillary action, like the refractive force, and all the chemical affinities, is only sensible at imperceptible distances.* Hauksbee has observed that the water is elevated to the same height in glass capillary tubes of the same diameter, whether the glass itself be thin or thick. If we only grease over the interior of a capillary tube, we cause the capillary effect to disappear sensibly: when the mercury in a glass capillary tube is boiled for a long time, it becomes elevated to its level, or even above it; this is because the

ebullition removes the aqueous film, which adhered to the interior surface of the glass: in the experiments made by Laplace with Lavoisier on barometers, they caused the convexity of the interior surface to disappear by boiling the mercury for a long time; they even rendered the upper surface concave; but they always re-established the capillary effect by introducing a drop of water into the tube. If now it be considered how little space the aqueous film can occupy, particularly when the tube and the mercury have been dried, and which yet does not destroy the capillary effect; it may be inferred that the action of the glass on the fluid is not sensible except at insensible distances.

Adopting this principle, M. Laplace has determined by the formulæ in his Treatise on celestial Mechanics, the action of a fluid mass terminated by a spherical surface whether concave or convex, upon a fluid column contained in an infinitely narrow canal coinciding with the axis of that surface. By this action he means the pressure which the fluid contained in the canal will exert, in virtue of the attraction of the entire mass, upon a plane base, situated in the interior of the canal, perpendicularly to its sides, at any sensible distance whatever from the (upper) surface, this base being assumed for the unit. He shews that this action is smaller when the surface is concave than if it were plane, and greater when the surface is convex. His analytical expression is composed of two terms, the first of which, much greater than the second, expresses the action of the mass terminated by a plane surface; and he thinks that on this term depend the phenomena of the adherence of the bodies to one another, and of the suspension of the mercury in a barometer tube, at an altitude two or three times greater than that which is due to the pressure of the atmosphere. The second term expresses the part of the action due to the sphericity of the surface; and is positive or negative according as the surface is convex or concave. M. Laplace shews that in both cases this term is inversely as the radius of the spherical surface: hence he deduces this general theorem, namely, that in all the laws where the attraction is only sensible at insensible distances, the action of a body terminated by a curve surface upon an interior canal infinitely narrow, and perpendicular to that surface in any point whatever, *is equal to the half sum of the actions upon the same canal, of two spheres which have for radii the greatest and the least radii of curvature of the surface at such point.* By means of this theorem and the laws of the equilibrium of fluids, may be determined the figure which a fluid mass must take when solicited by gravity. This philosopher proves that in a cylindric tube of a considerable diameter the section of the surface of the fluid by a vertical plane is a curve of the kind which geometers call *elastic*, and which are formed by an elastic plate bent by a weight; it thence results, that in that section, as in the elastic curve, the force due to the curvature is reciprocally as the radius

of the osculatory circle. If the tube be very narrow, the surface of the fluid approaches the nearer to that of a spheric segment as the diameter of the tube is the smaller; from which it is proved that in various tubes of the same matter, these segments are very nearly similar; whence it follows that the radii of their surfaces are still more nearly proportional to the diameters of the tubes.

The application of these results gives the true cause of the ascension or depression of fluids in capillary tubes, in the inverse ratio of their diameters. If by the axis of a tube of glass, we conceive an infinitely narrow canal, which turns up a little below the tube till it comes to the plane and horizontal surface of the water of a vessel in which the lower extremity of the tube is immersed; the action of the water of the tube upon this canal will be less, by reason of the concavity of its surface, than the action of the water in the vessel upon the same canal; the fluid must therefore rise in the tube, to compensate for this difference; and as this is, by what has preceded, in the inverse ratio of the diameter of the tube, the elevation of the fluid above its level must follow the same ratio.

If the fluid be mercury, its surface in the interior of a glass capillary tube is convex; its action upon the canal is therefore stronger than that of the mercury in the vessel, and the fluid must *sink* in the tube in proportion to that difference, and consequently in the inverse ratio of the diameter of the tube.

Thus the attraction of capillary tubes has no other influence on the elevation or depression of the fluids which they contain, than in determining the inclination of the first planes constituting that part of the upper surface of the interior fluid which is extremely near the sides of the tube; an inclination on which depend the concavity or the convexity of that surface and the magnitude of its radius. If by the effect of the friction of the fluid against the sides of the tube the curvature becomes either augmented or diminished, the capillary effect will be augmented or diminished in the same proportion.

Clairaut has made this singular remark, viz. that if the law of attraction of the matter constituting the tube differs not more than by its intensity from the law of the attraction of the fluid upon itself; the fluid rises above the level of the fluid in the basin so long as the intensity of the first of these attractions surpasses the half of the intensity of the second. If it is exactly the half, the surface of the fluid in the tube will be horizontal, but will not be elevated above the level. If these two intensities are equal, the surface of the fluid in the tube will be concave and hemispherical, and the fluid will be elevated. If the intensity of the attraction of the tube is nothing or insensible, the surface of the contained fluid will be convex and hemispherical, while the fluid will be depressed below the level. Between these two limits the surface of the fluid will be that of a spheric segment, and it will be con-

cave or convex according as the intensity of the attraction of the matter of the tube upon the fluid, is greater or less than the half of that of the attraction of the fluid upon itself.

If the intensity of the attraction of the tube upon the fluid surpasses that of the attraction of the moleculæ of the fluid towards one another, it then appears probable that the fluid attaches itself to the tube, and forms an interior tube, which alone elevates the rest of the fluid, whose surface will be concave and that of a hemisphere. M. Laplace presumes that this is the case with water in a glass tube.

After having considered fluids terminated at top by spheric surfaces, this philosopher considers those which are terminated by cylindric surfaces. Such is the case of a fluid contained between two parallel planes very near to one another, and having their lower extremities immersed in a vessel of the same fluid. He finds by his analysis that the fluid must rise or fall according as the upper cylindric surface is concave or convex, and that the elevation or depression still conforms to the inverse ratio of the mutual distance of the planes. He finds, moreover, that the elevation or the depression is equal to that which obtains in a cylindric tube of which this distance is the interior radius. This result of the analysis is confirmed by a series of experiments made by M. Haüy, at Laplace's request. Afterwards, in revising what he had written on the capillary action, M. Laplace found that these experiments had been made with much care, before the Royal Society of London, and under the eyes of Newton, and that their results are exactly conformable to the analysis. To be convinced of this read a passage in his Optics, "an admirable work, in which his profound genius has cast, beforehand, upon his age, a great number of original views, which the modern chemistry has confirmed." See Quest. 31, pa. 366, 367, of the English edition.

The capillary phenomena of inclined planes and of conical and prismatic tubes, are so many corollaries of M. Laplace's analysis. Thus it is observed that a small column of water in a conical tube open at both extremities, and placed horizontally, is carried towards the summit of the tube; and it is manifest, from what has preceded, that this ought to be. In fact, the surface of the fluid column is concave at its two extremities; but the radius of the surface towards the summit is smaller than of that towards the base; the action of the fluid upon its own moleculæ is therefore *less* on the side of the summit, and consequently the column must tend towards that side. But if the fluid column be mercury, then its surfaces are convex, and still its radius is less towards the summit of the cone than towards the base; whence, by reason of its convexity, the action of the fluid upon itself is *greater* towards the summit, and the column must move towards the base of the tube.

We may balance this action by the proper weight of the column,

and hold it suspended in equilibrium, by inclining the axis of the tube to the horizon. A very simple calculus shews that if the length of the column is very small, the sine of the inclination of the axis will then be nearly in the inverse ratio of the square of the distance from the middle of the column to the vertex of the cone: the same has place likewise, if, instead of moving a drop of fluid in a conical tube, we cause it to move between two planes which form with one another a very small angle. These results are strictly conformable to experiments, as may be seen in Newton's Optics, before referred to.

The calculus shews moreover that the sine of inclination of the cone's axis is then very nearly equal to a fraction, whose denomination is the distance from the middle of the drop to the summit of the cone, and denominator the altitude to which the fluid would be elevated in a cylindrical tube whose diameter is equal to that of the cone at the middle of the column. If two planes which contain a drop of the same fluid, form between them an angle double of that formed by the axis of the cone and its sides; the inclination to the horizon of the line which bisects the angle formed by the planes, must only be half of that of the cone's axis, so that the drop may rest in equilibrium.

Laplace's theory furnishes likewise the explication and the measure of a singular phenomenon presented by experience. Let the fluid rise or fall between two vertical and parallel planes immersed in the fluid by their lower extremities; these planes tend to draw nearer one another. The analysis shews that if the fluid rises, each plane experiences a pressure from *without* equal to that of a column of the same fluid, whose height is half the sum of the elevations above the level of the points of contact of the interior and exterior surfaces of the fluid with the plane, and whose base is the part of the plane comprised between the two horizontal lines drawn through these points. If the fluid falls between the planes, each of them will experience from *within* a pressure measured by that of a column of equal base, and altitude half the sum of the depressions below the level in the vessel.

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*Observations.*--We present our readers with as copious an account as our limits will permit, of this interesting paper; as we conceive that, in conjunction with Dr. T. Young's paper on the cohesion of fluids, published not long ago in the Philosophical Transactions, it will furnish more hints towards a complete theory of capillary attraction, than all the essays which have yet been published on the subject, not excepting that of M. Clairaut in his excellent work on the figure of the earth.

*On the horizontal Moon. By Dr.* OKELY. *In a Letter from Mr.* H. STEINHAUER—*Phil. Jour. No. 53.*

ONE of the most remarkable optical illusions is that in consequence of which we suppose the sun and moon when in or near the horizon to be larger in diameter, than when they are seen in any more elevated part of the heavens. Dr. Okely seeks for the source of this illusion in the apparent flatness of the sky; but he conceives that he differs from all others in his manner of connecting one appearance with the other. He first endeavours to shew that the flattened concavity of the apparent heavens is not an illusion, but a reality; that is, that a horizontal point of the sky is really farther from an observer than a point in the zenith. To establish this Dr. Okely affirms that the blue concave superficies called the sky is something real and material, otherwise it would not appear coloured; and then adduces reasons for believing that the sky cannot be placed beyond the atmosphere of our earth. The smallest parts of bodies that are coloured being blue, it is concluded that the sky is either the atmosphere itself, or the smallest and most elevated vapours ascending in it, or both together. Since the heavenly bodies shine through it, it cannot be opake; and being itself of a blue colour, it cannot be perfectly transparent. Dr. Okely does not attempt to ascertain the height of the atmosphere, but takes it for granted that the distance of its farthest points from the centre of the earth has a finite ratio to the earth's radius; and that this ratio is probably less than 2:1. Hence, if the blue heavens which surround the earth and are concentric with it, have a semi-diameter not double that of the earth, it follows that their horizontal points, as viewed from any part of the earth's surface, must be farther from us than any that are nearer the zenith. This may be easily conceived by drawing two concentric circles, the inner to represent a section of the earth, the outer to shew the extent of the atmosphere, and then drawing a tangent to the inner circle to represent the horizontal plane: for then, the horizontal distance will be exhibited by the semi-chord of the smaller arc cut from the large circle, and the vertical distance by the versed sine of the same arc. The remainder of Dr. Okely's explanation is conducted upon the same principles as were adopted by Dr. Smith; being first started, we believe, by Hobbes, in his treatise *de Homine*, cap. 3, pa. 17.

*Observations.*—Dr. Okely has not, in our opinion, given a very explicit account of the hypothesis he adopts. His meaning however is, that the apparent heavens coincide with a part of the curve surface which terminates that portion of the atmosphere in

which the air is not too much rarefied to lose its effect of reflecting and refracting the rays of light; that the different particles of which this terminating curve is constituted reflect in preference the blue rays of the solar light; and that these rays transmitted to our eyes, form the image of a sky of that colour, a sky which forms not a concave hemisphere, but a segment of a sphere much less than its half. Now, our objection to this explication of the flattened sky, and the phenomenon of the horizontal moon as depending upon it, is, that it does not correspond with observations. Taking those observations of Dr. Smith, and of Mr. Robins, which are most favourable to Dr. Okely's hypothesis, we shall find that the horizontal distance of the apparent heavens is at most 4 times the zenith distance; whence it may be shewn by a computation that may be made by any one acquainted with the principles of the elementary geometry, that the altitude of the heavens, or of the sky, as explained above, is about 500 miles. But this is quite inconsistent with the statement of Kepler, De la Hire, and others, who affirm that at the height of 50 miles only the atmosphere is so rare (about 20,000 times the rarity of the air at the earth's surface) as to have no sensible effect upon the rays of light. And much more is it inconsistent with the opinion of Mr. Harris, who (in his Optics, pa. 167) shews that upon a very favourable supposition, the apparent distance of the moon in the heavens will be about 115 yards; and that in general the moon's apparent distance is less than 100 yards, and sometimes not above 50. It might farther be objected, that Dr. Okely's explication depends upon gratuitous assumption of the true cause of the blueness of the sky; a point respecting which the chief writers on colours, as Newton, Le Cat, Bouguer, Prieur, &c. are by no means agreed.

Dr. Okely, there can be no doubt, supposes that he is the first who has attempted to explain the phenomenon of the horizontal moon by the hypothesis that the blue sky terminates that part of the atmosphere which can change the progress of the rays of light; but in this respect he is under a mistake. The celebrated Haüy, in his *Traité elémentaire de Physique*, tom. ii. pa. 303, has recourse to the same supposition, but not to that solely: for, seeing that it is, of itself, inadequate to the correct explanation of the phenomenon, he supposes moreover that the objects which are interposed between us and the moon, when that luminary is near the horizon, contribute still more to augment its apparent distance with respect to the spectator, and to diminish the curvature which we attribute to that part of the vaulted sky. Indeed M. Haüy ascribes his explication, at least in the chief part, to Mallebranche, in his *Recherche de la Vérité*; but we suspect that the account of that celebrated metaphysician differs from Dr. Okely's in some important particulars. After all, we look upon the phenomenon of the horizontal moon to be one which has not yet been satisfactorily accounted for, except, perhaps, by Dr.

Berkeley. The student who wishes to acquaint himself with the principal opinions, may consult Bishop Berkeley's New Theory of Vision, arts. 67—78; Robins's Tracts, vol. ii. pp. 235—249; and Hutton's Mathematical Dictionary, art. *Apparent* MAGNITUDE.

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*Abridgment of certain Papers written on the apparent Magnitude of the horizontal Moon, and published at sundry Times. To which are added new Experiments to prove the Truth of the Author's Theory, and to exhibit a clear Representation of the Phenomenon on optical Principles. By* EZ. WALKER, *Esq.—Phil. Mag.* No. 95.

MR. Walker commences his paper on this interesting topic, by some remarks on preceding hypotheses, delivered in a flippant style but ill comporting with the dignity of candid philosophical discussion. "When men," says he, "in former ages began to reason on this phenomenon, they imagined that the angle subtended by the moon was really increased by a refraction of her rays, in passing through the vapours contained in the air near the earth's surface. But as soon as it became known that she subtended the least angle at the eye, when her apparent magnitude was greatest, philosophers said that the age was imposed upon, by the long series of objects interposed between the eye and the extremity of the sensible horizon. And after it was discovered that the same phenomenon was observed at sea where no land objects could be seen, they blamed the clouds for deceiving them; and when the clouds flew away, the spirit of inquiry flew after them, to seek for information in the apparent concavity of the sky."

The hypothesis of Mr. Walker is founded upon the well-known truth, that the dimensions of the pupil of the eye alter by the stimulus of light; in aid of which he calls in another principle, to which he attempts a demonstration, namely, that the picture of the moon upon the eye is not permanent, but varies as the dimensions of the pupil vary. Hence, he says, the cause of that variation which obtains in the apparent magnitude of an object, is no longer a matter of mere opinion; for it is an established law in dioptrics, that the image in the focus of a convex lens increases with the aperture of the glass, and consequently the picture of the moon in the focus of the crystalline lens of the eye increases as the pupil is enlarged.

This theory is illustrated by two experiments, one of which shall be presented to the reader. Mr. Walker had a frame made to contain seven convex lenses fixed in the arch of a semicircle. They were all of the same focal distance, but not of the same aperture. The two largest apertures measured each 1.2 inches; these were to represent the pupil of the eye when viewing the

moon at her rising or setting: the two next to these had each an aperture of 0.6 inches; the other two were still less; and the single lens at the top of the curve had the least aperture, to represent the pupil when the eye is exposed to the moon on the meridian. This instrument being fixed in a vertical position with a lighted candle before it, and a white screen behind it, brought to a certain distance within the focus of the glasses, the spectrums upon the screen appeared in the same ratio to each other as the glasses that formed them, and represented with much apparent accuracy the magnitude of the moon at the respective elevations.

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*Observations.*—It will be seen that although Mr. Walker's hypothesis is supported by the authority of mathematical demonstration, it may, notwithstanding, be inadmissible, since there is a principle assumed in the demonstraion which is not completely established. Is Mr. Walker *certain* that the figure of the crystalline, its position in the eye, the distance from the pupil to the retina at the back of the eye, or, in other words, the general dimensions and conformation of the eye, continue unchanged while the magnitude of the pupil varies? If he be, he has attained conviction on a point respecting which Harris, Wood, Porterfield, and others of our best writers on vision, have still many doubts. Yet unless this be a decided point, we conceive the whole of Mr. Walker's demonstration nugatory.

It is, however, probable that Mr. W. has, in this paper, suggested one great source of the illusion; but even if this be the case, it is not so much an explanation of the phenomenon as an elucidation of the former explanation of it, given by the acute Berkeley. This explanation, as it does not appear much known, it may perhaps be acceptable to describe briefly in the author's own words: "The particles which compose our atmosphere intercept the rays of light proceeding from any object to the eye; and by how much the greater is the portion of the atmosphere interjacent between the object and the eye, by so much the more are the rays intercepted; and by consequence the appearance of the object rendered more faint, every object appearing more vigorous or more faint in proportion as it sendeth more or fewer rays into the eye. Now, between the eye and the moon, when situated in the horizon, there lies a far greater quantity of atmosphere, than there does when the moon is in the meridian. Whence it comes to pass that the appearance of the horizontal moon is fainter, and therefore it should be thought bigger in that situation, than in the meridian or in any other elevation above the horizon." See art. 68 of Dr. Berkeley's Essay, cited in our observations on Dr. Okely's theory.

*On the Mammoth, or American Elephant, by which it is proved to have been an herbivorous Animal. In a Letter from the Right Rev. Bishop* MADISON.—*Philadelphia Med. and Phys. Journal, vol.* ii.

IT is now no longer a question whether the mammoth was an herbivorous or a carnivorous animal. Human industry has revealed a secret, which the bosom of the earth had, in vain, attempted to conceal. In digging a well near a salt-lick, in Wythe County, Virginia, after penetrating about five feet and a half from the surface, the labourers struck upon the stomach of a mammoth. The contents were in a state of perfect preservation, consisting of half-masticated reeds, twigs, and grass, or leaves. There could be no deception; the substances were designated by obvious characters which could not be mistaken, and of which every one could judge; besides, the bones of the animal lay around, and added a certain confirmation. The whole rested upon a limestone rock. Dr. Madison had not, at the time of sending his communication to Dr. Barton, seen any parts of this mammoth; for he was so well satisfied with the narration of gentlemen who had seen them, and upon whose veracity, as well as accuracy, he could rely, that he thought the journey unnecessary; especially as he took measures to ensure the transmission of a sufficient quantity of the contents of the stomach, together with all the bones, to Williamsburgh.

Dr. Madison's letter, which is dated October 6th, 1805, concludes with some remarks on the preservation of these and similar bodies; but does not pretend to decide whether it is the effect of marine salt, or of a petrification spoken of by Blumenbach, and which he calls *simplement calcinés*.

In a note by the Editor, some arguments are suggested in favour of the long preservation of vegetable matters, from an extract from the "Natural History of Ireland," by Dr. Boate, Dr. Molyneux, and others. The fact stated by Dr. Madison needs not, in our opinion, any confirmation from arguments.

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*A simple and accurate Mode of constructing Gasometers for Purposes where uniform Pressure is essential, by the Application of the hydrostatic Regulator. By* JOSEPH STEEVENS, *Esq.—Phil. Mag.* No. 94.

THIS gasometer is constructed on the principle of the hydrostatic regulator, invented by Mr. Steevens, and described in the 20th volume of the Philosophical Magazine. As it does not

appear easy to give a perspicuous account of this contrivance without an engraving, we choose rather to refer to the work in which is the original account, than to lay before our readers an obscure abridgment. It may not, however, be improper to mention that from the facility with which the pressure in this gasometer may be varied, it will be found a useful instrument in all cases where the blowpipe is used: it will also be found of utility in the filling of vessels for a variety of purposes in pneumatic chemistry; in playing jets of flame, and in illustrating the parabolic theory of projectiles.

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*Investigation of the Temperature at which Water is of the greatest Density, from the Experiments of Dr. Hope on the Contraction of Water by Heat at low Temperatures. By Mr.* John Dalton.—*Phil. Jour.* No. 54.

More than twelve months ago Mr. Dalton stated certain facts which led him to disbelieve the common opinion that water is densest at 40° of Fahrenheit, and inclined him to think it was at 32°. Since then he has been able to demonstrate, at least, to *his own* satisfaction, that the temperature at which water is of greatest density is at or near 36°. The object of Mr. Dalton's present communication is to shew that the results of Dr. Hope's experiments are explicable on the supposition of water being densest at 36°, but on no other. M. Deluc was the first to observe that the expansion of water, on each side the temperature of greatest density, is the same quantity for the same number of degrees, whether of increase or diminution of temperature. Mr. Dalton has lately examined this fact with greater attention than formerly, and finds that it is accurate, except that the expansion for degrees *below* the stationary point is always somewhat more than for a corresponding number of degrees *above* the said point.

Mr. Dalton and Dr. Hope concur in opinion that water may in certain circumstances continue fluid below its freezing point, even as far as 25°. Mr. D. then quotes an experiment of Dr. Hope's, from which he infers that water descends as it acquires heat, until the temperature rather exceeds 36°: after which the heated water ascends; but that the circumstances do not agree with the supposition of the maximum density being at 39° or 40° of Fahrenheit.

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*Observations.*—The remarks which we made on Dr. Hope's paper on the same subject, in our 4th Number, seem rather applicable in the present case. Experiments cannot surely be all conducted with the requisite cautions, if they lead gentlemen to deduce such different conclusions from them, when pursuing them at different times, or viewed in rather different lights. We would not wish the philosophers of the present day to lock up the results of their investigations and experiments in their escrutoires;

but we would ardently recommend them, to *repeat* their inquiries, to try their experiments under great variety of circumstances, to watch sedulously the effect of every modification of those circumstances, to make slow and circumspect deductions from the whole, and then to lay before the world a methodical detail of all they have accomplished, as well as the path they have pursued; instead of offering to notice separately, as they arise, every isolated fact, and every individual experiment. While we are very ready to yield the testimony of respect to the talents and diligence of Mr. Dalton and many other philosophers of these times, we would venture to remind them of the grand maxims which enabled Bacon and Galileo to cast off the shackles of the Aristotelians; and even to observe that, had the illustrious Newton published the results of his experiments and researches in optics and physical astronomy, by scraps at the end of every two or three months, leaving them to others to systematize and arrange, it is highly probable that his name, instead of being now pronounced with reverence, would long ago have sunk into obscurity.

Since these remarks were written we have perused another communication from Mr. Dalton, in No. 56 of the *Phil. Jour.* in which he attempts to shew how the farther consideration of Dr. Hope's experiments confirms his opinion of the maximum density being at the temperature of 36° on Fahrenheit's scale.

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*On Fairy Rings. By* A. T.—*Phil. Jour.* No. 54.

This writer has generally observed that fairy rings are most prevalent, in light sandy soils, particularly among rabbit-burrows; and that the rings were composed of a double circle, or rather a little circular path, the middle of which appeared to be trodden, and the edges grown up, and more vigorous than any of the surrounding grass. He remarked carefully one of these rings last summer: it was perfectly circular, and about 10 feet in diameter; it was situated at the edge of a copse, and in a vicinity where there are abundance of both hares and rabbits; but what appeared most singular, was its being intersected exactly through the middle by a well-frequented foot-path.

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*Account of a simple and cheap portable Barometer, with Instructions to enable a single Observer to determine Heights by that Instrument with considerable Facility and Precision. By Sir* H. C. Englefield, *Bart. M. P. F. R. S. &c.—Phil. Jour.* No. 55.

Although the mensuration of heights by the barometer and thermometer has been reduced to accurate, and tolerably com-

modious, scientific rules, more than thirty years ago, yet this method has not during that interval been practised by any means so often as might be wished. The chief causes of this seem to be, that the instruments are costly, liable to be deranged, the observations requiring time and care, and the supposition that two observers with separate instruments were necessary. Hence it has happened that the elevations and depressions of the earth's surface, though of high utility and interest in topographical researches, are seldom accurately noted by travellers.

The ingenious and public-spirited Baronet, with a view to remove the chief impediments to frequent observation, has simplified the instrument, shewn that one observer may obtain valuable results, and has furnished a table to facilitate the computation. His barometer is an improvement upon that by Dr. Hugh Hamilton, described in the 5th vol. of the Transactions of the Irish Academy; and is light, firm, and susceptible of great ease in the application.

The barometer tube is about $33\frac{1}{2}$ inches in length; its bore one tenth of an inch in diameter, and the external diameter three tenths of an inch. The cistern is of box, perfectly cylindrical, an inch in its internal diameter, and an inch in depth. A short stem projects from its top (when in the position for observations), to give a firmer hold to the tube. This stem has a perforation sufficiently large to admit the tube, which is glued to it in the usual way. The tube reaches to the middle of the depth of the cylinder, the bottom of which is closed by a screw-cap and leather. This tube being filled and boiled in the common way, and the instrument held inverted in a perpendicular position, mercury is poured into the cistern till it is filled within a fifth of an inch of the top; then the lid is firmly screwed on, and secured from being opened by a small screw passing through its side. The end of the tube in the cistern can never be uncovered by the mercury in any possible position, and of course no air can ever enter it: and since the areas of the cistern and the tube are as the squares of the diameters, it may easily be shewn that the mercury must fall $18\frac{1}{5}$ inches before the cistern is quite full, a space more than adequate to the measure of the highest mountains on the earth. When this barometer is set upright the atmosphere acts upon it through the pores of the wood. The variations of altitude in this instrument, when the dimensions are as above stated, will be one ninety-first part less than in a barometer furnished with an apparatus for bringing the surface of the mercury in the cistern to a fixed level: this defect might be remedied by a correspondent division of the scale; but it is much more convenient to divide the scale to real inches, and make the necessary allowance in the result. This barometer is mounted in a mahogany tube of the size of a walking-stick, and has attached and detached thermometers.

For the observation of the height of the mercury, two opposite

slits are cut in the mahogany tube, reaching from about 32 to 20 inches, for the longer scales, or from 32 to 25 for such as are intended to be used in this country. The front slit has its sides bevelled, and is exteriorly about $\frac{3}{4}$ of an inch wide; having a brass plate fixed on one side, divided as usual, to inches, tenths, and twentieths. On this plate slides a nonius moveable by a small knob, which reads off, as in other barometers, to the 500th of an inch: to this nonius is attached a small portion of brass tube, which embraces the barometer tube; its lower edge being in observation made a tangent to the convex surface of the mercury, as in other well-constructed barometers, and the very narrow slit behind furnishes sufficient light for observation.

When Sir Henry proposes to make an observation, about five minutes before he arrives at the place he takes out the detached thermometer from its place in the end of the mahogany tube, holding it by the upper end at nearly arm's length from his body, and, if the sun shines, in the shade of his person: it very soon takes the temperature of the air, and is not sensibly affected by the heat of the hand. The heat being observed and written down, the barometer is turned up, the brass tube half turned, and the instrument held between the finger and thumb of the left hand above the slide, so as to let it hang freely in a vertical position. Since few persons, if any, have sufficient steadiness of hand to prevent little vibrations in the mercury in this position; the hand should be either rested against any fixed body, or, if no such occurs, by kneeling on one knee; the cistern should be let down so as to touch the ground, the left hand holding the barometer in a vertical position, which a little practice will render easy. The index must then be moved by the knobs till its under surface is tangent to the mercury: and a few slight taps should be given to the tube, to ascertain that the mercury is fallen as low as it can. The height being then read off and registered, together with that of the attached thermometer, the brass tube is turned back so as to cover the slits, the instrument gently inverted; and the whole is finished in about two minutes.

Sir Henry does not detail the rules by which the altitude may be deduced from the observations, since these have been given by many authors. But he furnishes a table which may be engraven on the barometer, that will enable a traveller to compute altitudes with great facility, and the results not deviating far from the truth. He remarks that observations with a single barometer may lead to tolerably accurate results; and states his method of proceeding to be this:—At setting out he takes the height of the mercury, and notes the time of observation. He likewise notes the time of the second observation, and on returning to the first station observes again and notes the time: if the barometer has varied in the interval, a simple proportion corrects either of the three observations, and reduces the height to what would have

been observed had the mercury been stationary. This method, however, supposes the mercury to have moved uniformly in the interval between the observations, a supposition fairly admissible except in very changeable weather: and it is also supposed that a traveller has an opportunity of making a second observation at the spot he set out from. Where this is not the case, a near approximation may often be made by observing, for example, at a stream on each side of the hill to be measured. If also he observes the barometer repeatedly in the morning before he sets out, and sees its tendency, and does the same at every halt during the day, he will have data whereon to found a nearly accurate correction.

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*Observation.*—The preceding account will shew the nature and object of Sir H. C. Englefield's contrivances and rules: the geologist, mineralogist, military surveyor, or philosophic traveller who wishes to put them in practice, may obtatin farther useful information by consulting the Number of the Philosophical Journal referred to at the head of this article.

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*Observations on the Dispersion of the Light of Lamps by means of Shades of unpolished Glass, Silk, &c.; with a Description of a new Lamp. By* Benjamin *Count of* Rumford.—*Phil. Jour.* No. 55.

In this paper the Count enters pretty copiously into many particulars connected with the subject of vision, the dispersion of light, the effects of shades, the construction of lamps, &c. Thus, he remarks that vision is very distinct, satisfactory, and unfatiguing to the eye, although the light from the radiant object have different intensities: that distinctness depends much on the simplicity of the shadows of bodies: that the prejudicial effects of a direct glaring light of lamps upon the eye may be remedied by a semi-transparent shade: that, although the use of shades has been circumscribed from a notion that they darken, yet experiment shews that roughened glass does not intercept more light than polished glass; the reason of which is, that the minute cavities of rough glass have sides smooth and shining. A clear glass globe, the Count observes, when surrounding a lamp, is scarcely seen; while, if the glass be roughened, it emits light from every part: the light is thus softened, and very little lost by internal reflections. The power of a shade to soften and disperse light, and that of intercepting light, are widely different qualities. Count Rumford gives instructions for ascertaining the power of dispersing or softening the light, as well as for illuminating generally: thus illustrating the use of the photometer, and of another instrument which he describes in this paper. He shews that the larger the shade the less luminous it will appear when looked at; and hence infers,

that when small spherical shades of roughened glass emit too dazzling a light, the natural remedy is to make the shade larger.

One of the Count's practical remarks, though not immediately connected with the subject of this paper, is too important to be omitted. It often happens in great towns that a room has no other light than what it receives by windows which open into a small court, surrounded on all sides by high buildings: in these cases the room would be more copiously and better lighted by panes of roughened glass than by transparent panes. The rays of daylight which descend almost vertically from above into the court fall upon the panes at so small an angle of incidence, that, when the exterior surface of the glass is polished, they are in great part thrown off by reflection, and do not enter the room; and even those which, not being reflected, pass through the pane, as they fall directly upon the floor where they are almost all absorbed, the objects in the room are very little enlightened; but when the pane is roughened, the asperities of the glass presenting to the descending rays surfaces less inclined, more of the rays enter the glass, and passing through it afterwards in various directions, light is diffused in all the parts of the room. The same observations will apply to all cases where a high wall is opposite a wall at a small distance.

The following is a contracted description of Count Rumford's lamp, which is destined to be suspended in the middle of a room, such as a dining-room, a drawing-room, &c. A hollow hoop of tin painted white 12.8 English inches in diameter within, and 16 inches in diameter without, and .8 of an inch deep, suspended horizontally, serves as a reservoir for the oil. In the centre of this circular reservoir there are three cylinders or beaks, which enclose three circular wicks of the usual form and size. These three vertical cylinders which touch each other, are soldered together, and connected with the reservoir by means of three oblique tubes $\frac{9}{20}$ of an inch square, through which the oil flows to the wicks from the reservoirs. In order to catch the oil which occasionally drops from these three cylinders, there is a tin cup of $4\frac{1}{2}$ inches in diameter above at its opening, and 1 inch deep in the middle, which is placed $\frac{3}{4}$ of an inch below the lower ends of the three cylinders. Each of these cylinders is furnished with a chimney, or tube of glass, and they may be lighted either all three together, or two, or one only, according to the required quantity of light. This lamp is suspended by means of a hoop of gilded brass 16.2 inches diameter, and $1\frac{1}{2}$ wide, having an internal horizontal projection at its lower edge, on which the circular reservoir of the lamp rests. Three arrows of gilded brass are fixed to this hoop at equal distances from each other: these arrows are 6 inches long, and .4 of an inch diameter, and are in a horizontal position, on the outer side of the hoop, and in the direction of three radii drawn from its centre. To these three arrows are

fastened, at 3 inches distance from the loop, the ends of three chains of gilded copper, each 28 inches long, by which the hoop that receives the lamp is suspended. These arrows serve the purpose of separating the chains from each other, in order that the lamp may be removed occasionally, and replaced, without deranging the chains. For a lamp with four wicks which serves to light a large drawing-room, the gilded hoop that receives the lamp has six arrows, to which are attached six chains; and one of these chains, being attached to its harrow by a small hook, is occasionally detached to allow a passage for the lamp.

The gilded hoop which receives the lamp is ornamented with pendants of crystal; and from the lower edge of the hoop immediately behind the crystal ornaments there descends a hoop of white crape, of the same diameter as the brass hoop, and $4\frac{1}{2}$ inches in breadth, which serves to disperse and soften the direct rays of the flames of the lamp. To reflect a part of the rays that mount towards the ceiling in order to destroy the shadows that might be formed under the lamp, there is a conical reflector of white crape, which resting on the three tubes that conduct the oil from the reservoir to the wicks, surrounds and conceals the glass tubes that contain the flames. This reflector is $12\frac{1}{2}$ inches in diameter below, $5\frac{1}{4}$ inches in diameter at the opening above, and 6 inches high.

The chief difficulty to be overcome in the construction of this lamp was to contain the oil in the reservoir in such a manner that it should not be in danger of being spilled when the lamp is taken out of the hoop in which it is suspended: to guard against this, the reservoir is closed above, so as to form a hollow hoop, and it has three openings on its upper surface, equidistant from each other. These openings, which serve for pouring the oil into the reservoir, are each $\frac{7}{10}$ of an inch in diameter, and are hermetically closed by three stoppers of brass, ground with emery. In the axis of each of these stoppers there is a small hole $\frac{3}{20}$ of an inch in diameter, which is occasionally closed by a small screw furnished with a collar of leather. When the reservoir is filled with oil, the three stoppers are put in their places, and the small holes are then closed by means of the three screws.

The lamp admits of variations of construction while the same principle is retained, to suit it for rooms of different magnitudes. Some of these variations are described, and an illustrative plate given, in the Philosophical Journal, No. 55.

*On the Utility of the hydraulic Ram, invented by M.* Joseph Montgolfier.——*Bibliotheque Phys.-Econ.* No. 5. vol. i. 1806; *and Journ. des Mines,* No. 104.

The construction of this machine is founded upon the acceleration of the velocity of a liquid mass falling in a tube, and the communication of that motion to another liquid mass moving with a less velocity than the former. We know that a heavy body falling in vacuo runs over $16\frac{1}{12}$ feet in the first second; and a liquid column which falls in an unresisting vertical tube passes over the same space in the same time, with a motion uniformly accelerated: supposing this tube kept constantly full, and considering the friction of the particles of the fluid against one another, and against the sides of the tube, the motion is such, that, though it ceases to be uniformly accelerated, the velocity of the column, at first nothing, arrives by degrees at its maximum, in a longer or shorter time, depending on the dimensions and form of the tube: the contained fluid having acquired a certain velocity, there results a certain quantity of motion; the object of the hydraulic ram is to communicate a part of this motion to the mass of water which is to be elevated.

To understand the construction of this machine, suppose that an orifice is made through the pier or embankment of a reservoir of either standing or running water, at the depth of 4 or 5 feet below the surface of the fluid, such orifice receiving one end of a cylindrical tube about 20 or 24 feet long, the tube being formed of iron, copper, or other suitable materials, and placed horizontally, and firmly supported through its whole length by timber or by masonry. To the end of this tube farthest from the reservoir is adapted a piece of iron or of copper, called *the head of the ram:* it has two orifices, both of which open horizontally; the sucker of one of these closes by ascending, that belonging to the other closes by descending: these valves are guided in their motions by rings which traverse the handles attached to their centres. The orifice which has the ascending valve, and which is in fact the remoter orifice, permits the water to escape freely: the other is covered by a kind of tower, which serves as an air-vessel, and is pierced on one side by a hole to which a tube is adapted that is elevated to the height to which it is proposed to raise the water.

To understand the action of the machine, let it be considered that when the remoter orifice is open, the water which runs along the horizontal tube will escape with a velocity which will continue to increase until the impression of the stream raises the valve and closes the orifice: hence the motion of all the water in the ube is suddenly stopped, and the *vis viva* acquired exert

itself on all parts of the tube, and consequently on the rising valve, which giving way permits the water to escape through it into the vessel above: the force existing in the cylinder being thus employed, the pressure to which the valve yielded becomes annihilated, and the sucker redescends, closing its orifice: the velocity of the water in the horizontal tube being thus destroyed, the remoter orifice again permits the water to escape through it, and the same operations are repeated so long as there is a proper supply of water. Thus it will be seen that every time the valve closes the remoter orifice, a portion of the moving water passes into the air-vessel above the other valve; there will soon be a sufficient quantity to cover the inferior extremity of the ascending tube, and then the air which is above the water in the air-vessel, having no communication with the atmosphere, will be compressed if the machine continue to act, and its expansive force increasing with the compression will compel the water to move up the ascending pipe; though always in a quantity inversely proportional to the altitude to which it is to be raised.

Every time the remoter or discharging sucker shuts, a report is heard similar to that of the stroke of a hammer, and which furnishes a mean of knowing how often it is closed in a given time.

We have only spoken of one kind of ram; but the same principles are susceptible of a very extensive application: thus, it would be easy to raise other water besides that which runs through the ram; as, for example, with a fall of water, we might by a slight modification of this machine raise water from the bottom of wells or of mines.

To judge of the merit of a hydraulic machine we must consider its produce, the expense of its erection, and that of keeping it in repair. Now in every hydraulic machine the force expended is the product of the water which comes from its source multiplied by the height it falls through before it acts on the machine; the produce being the product of the quantity of water raised in the same time, multiplied by the height to which it is elevated. Applying this rule to the celebrated machine at Marly, when the water of the Seine is at the lowest, and all the other circumstances are the most favourable possible, the expense is to the produce only as 60 to 1; and even at its first erection, the proportion was as 24 to 1.

Now, in an experiment made upon the ram erected at the Polytechnique School, it appeared that the expense was to the produce as 100 : 45. For, the height of the fall is 1 metre 82, that of the ascending pipe 11 m. 66, the tube of the vertical or active column .054 m. in diameter, being fixed at the bottom of an oval-shaped vessel; the horizontal or passive column, also .054 m. in diam.; the ascending tube of tin .002 m. interior diam. and 11 m. 66 elevation; the total length 32 m. 66. The discharging valve

closed from 40 to 42 times in a minute. The water which fell in 10 minutes was 493.7 litres; that which was raised up the ascending tube in the same time 51.8; from which data flows the ratio just stated.

In another hydraulic ram placed in M. Montgolfier's garden (Rue des Juifs, No. 122) the fall which was procured artificially was $7\frac{1}{2}$ feet; the height to which the water was raised, 50 feet; the diameter of the tubes 2 inches; the water expended in 4 minutes was 315 litres, that elevated 30 litres: hence the expense or force employed is $7\frac{1}{2} \times 315 = 2362$; the useful force $50 \times 30 = 1500$; and these are in the ratio of 100:64.

In an experiment made upon a ram at Avilly, near Senlis, by M. Turquet, bleacher, the expense was found to be to the produce as 100:62. An experiment on a fourth machine, in which the passive column was 10 m. 4 in length, and the height of the ascending pipe nearly 7 times that of the head of water, the discharging valve closed 104 times in a minute, and the expense was to the produce as 100:57. Taking the mean of these experiments, the expense will be to the produce as 100:57; so that a hydraulic ram placed not in unfavourable circumstances and executed with care, may be said to employ usefully at least half its force.

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*Observations.*—We have described this machine and its effects pretty much at length, not because there is much novelty in the principle, for in truth there is very little, but because we are not aware of any such machine having ever been constructed in this country, except, perhaps, those under Mr. Boulton's patent (for the specification of which see Repertory of Arts, &c. vol. ix. first Series), notwithstanding its comparative simplicity, durability, and cheapness, would induce many to adopt it, who were once acquainted with its nature. One of our most simple engines for purposes similar to those in which the *ram* could be applied, is Sarjeant's bucket engine (see pa. 319, of our first volume), in which the expense is to the produce nearly as 100 to 42, a ratio not much inferior to that of the ram at the Polytechnique School. But the machine most analogous to M. Montgolfier's in principle next to that by Mr. Boulton, is the celebrated hydraulic engine at Chemnitz, in Hungary: in this curious specimen of machinery, the expense is 66 feet of water falling 136 feet, in the same time that the produce or performance is 32 feet raised 96; they are therefore in the proportion of $66 \times 136$ to $32 \times 96$, or nearly as 100:34. Even this is superior to the performance of the most perfect undershot mill, and might certainly be considerably increased, by giving more favourable proportions to the feeding and discharging pipe, than in the existing machine. And if, in addition to this, the ingenious apparatus of Mr. Boswell, enabling the machine to work itself (see Phil. Jour. 4to. vol. i. and 8vo. vol.

ii.) be appropriated skilfully to such a general contrivance, it will doubtless be as favourable as the hydraulic ram. M. Montgolfier suggests the utility of his invention in the draining of mines: and in that case, the hydraulic ram, and the Hungarian machine, would become nearly, if not altogether, identical as to the principle.

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*Observations on the Danger of using Earthen-ware or Pottery of a bad Quality. By* M. Poidevin, *of Rouen.—Ann. de Chim.* No. 163, *tome* 55.

Pure white argil forms the body of the finest pottery, which bears the name of porcelain; clays less pure, and more or less coloured with iron, serve to form the stone-ware, or hard earthen-ware, and the common or soft sort, which differs from the other in not experiencing a commencement of fusion at their surface in baking, like porcelain or stone-ware. This badly-prepared common earthen-ware is the kind which is sometimes attended with danger in its use, and is the subject of this paper.

M. Poidevin states first the composition of the biscuit of brown earthen-ware, and the differences in the ware, from the quality of the component substances: he then describes the white enamel, as composed of siliceous sand, a little lime, lead, and tin oxides, and some flux, ground together with water in mills. The brown sort is composed of the same materials, with the addition of manganese and Perigord stone. This writer next describes the constituent matters of brown and yellow pottery, and their respective glazes, the mottled streaks in French ware, the cloudy tinges in the glaze, &c. and then proceeds to state the causes of the imperfections which are produced in pottery.

The means, he says, of producing good pottery and earthen-ware, consist in choosing with care the earths for forming the body; in producing an exact coincidence of expansion by heat between them and the vitrifiable glaze with which they are to be covered, and in baking them by a proper degree of fire, produced from such combustibles as are not capable of changing the nature of the glazing. The neglect of these points occasions defects in the manufactured articles, which are either merely unsightly, or both unsightly and prejudicial.

The unsightly defects in ill-conditioned pottery or earthen-ware, are, *scaling*, *dropping* or *drops*, *smoke*, *drying*, and *flaws* or *cracks*. *Scaling* is the term used when the glazing of a piece detaches itself in scales, by the action of humid air, or by the touch, and leaves the biscuit uncovered. The *dropping* or *drops* take place when the moisture of the fuel having affected the pieces during the baking, the enamel is collected in *drops* on the surface, and remains vitrified in that form, instead of being spread uniformly. The *smoky* appearance is seen when a piece has not been purified

by a clear flame, but remains blackened or stained. The *drying* happens when the pieces come out rough from the absorption of the enamel into their substance. The *flaws* happen when the earth or the biscuit having a different pyrometrical expansibility from that of the enamel, the body contracts more in cooling than the glaze, which is therefore split.

All these defects, though disagreeable to the eye, have really, with regard to the ware itself, only the inconvenience of a dirty appearance, provided the biscuit is always compact and well baked. But in the common pottery, the dropping, scaling, and flaws produce injurious defects: for, as in these the earth is more porous and less baked, the liquids preserved in them enter into the pores, where they undergo a decomposition and produce sulphurated hydrogen, which injures every thing kept in them.

The most noxious defects in pottery are the cavities or pits, and the under-baking. The pits are hollow bubbles which are found on those pieces whose enamel being injured by rubbing, or being too little acted upon by the fire, has not been fused into a vitreous substance. In these the metallic oxides are in a state capable of doing injury, being still soluble in fat or acid substances.

But one of the most dangerous defects is occasioned by the under-baking: the pieces thus affected have not had sufficient heat to cause the enamel to do more than agglutinate together, and in some cases it still remains in powder. Hence it is capable of being divided and taken up by all the liquids with which it may come in contact.

The public must, then, be exposed to danger in buying those articles at a low price, which are called refuse, and which ought to be carefully destroyed or thrown away. For, although they may be used daily without the occurring of any immediate mischief: yet, if the injury be more concealed, it is not, therefore, less destructive. Lead and its oxides act insensibly on the organs of digestion, when taken in small quantities: at length, however, they cause infallibly emaciation, colics, convulsions, with obstinate diarrhœas; and the wretched people who use such vessels become the victims of their own ignorance, and of the imprudent avarice of the manufacturer.

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## *Description of several Improvements on Lathes. By Mr.* J. J. Hawkins.—*Rep. of Arts*, No. 48, *New Series.*

Mr. Hawkins having lately attained many useful improvements in turning, through the ingenuity of his friends and workmen, and having introduced them into his piano-forte manufactory, has communicated two or three of them as hints for the public.

His method of tuning piano-fortes with screws, each working

a sliding piece of brass, to which the string is fastened by means of a hook, required that the hook should be an inclined cylinder, formed out of the sliding piece; these inclined cylinders are cut in the turning lathe by the following process. To make the tool, a piece of steel is fixed in a chuck in the lathe, and a conical hole turned in the end of it, the smallest diameter being outward, and equal to that of the required cylinder. The angle the side of the cone makes with its axis is equal to the required obliquity of the cylinder. The end of the tool is cut like the teeth of a saw, the sharp edges of which are in a plane perpendicular to its axis. An inclined plane parallel to the side of the conical hole, is fitted at the front: and a frame containing the article to be cut slides down this inclined plane, when by the revolution of the tool the oblique cylinder is formed, leaving the part surrounding the base quite flat.

Mr. Hawkins's manner of tuning piano-fortes also requires that he should cut a number of oblong transverse apertures, in a piece of brass about three feet long; to do which he formerly fixed a small circular saw on a long rod in the lathe, but this throwing the saw so far from the treadle, made it necessary to employ two persons. For this inconvenience Mr. H.'s father contrived an ingenious remedy: he put the saw on a short mandrill, fixed on a puppet, standing obliquely from the axis of the lathe, so that a line produced from this mandrill would pass entirely clear of the pulley of the lathe: this small oblique mandrill is turned from the mandrill of the lathe by an universal joint; of which, the most approved for the purpose is a hook and eye.

Much time is lost in turning a number of small articles on two centres, with all the common methods of fastening the centre head or sliding puppet of lathes, in consequence of their requiring the workman to stoop, every time he tightens or loosens it, the fastening being at the bottom. But numerous advantages arise from having the fastening at the top of the puppet, a method suggested to Mr. H. by an ingenious Englishman, in Philadelphia.

Figures illustrative of these contrivances accompany their description in the Number of the Repertory, from whence we have extracted this account.

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*Observation.*—Mr. Hawkins displays an indefatigable zeal in the pursuit and adoption of every contrivance that may tend to the accomplishment of the various objects of his patent: and we trust, that zeal and industry like his will meet with a suitable reward from the favour of the public.

*Account of the Regulation proposed to Parliament by Mr.* ROBERT VAZIE, *to prevent Frauds in the Measurement of Coals.—Rep. of Arts,* No. 48, *New Series.*

THE various impositions to which the consumers of coals in the metropolis are subject, in the sale, admeasurement, and delivery of that article, have from time to time attracted the attention of the legislature.

In the 16th and 17th years of the reign of Charles II. an act of parliament was passed, directing, "that all coals brought into the river Thames, and sold by the chaldron, shall be at the rate of 36 bushels *heaped up*, according to the bushel measure sealed for that purpose at Guildhall."

And in the 12th year of the reign of Queen Ann, it was enacted, "that the coal bushel shall be round, with an even bottom, and be $19\frac{1}{2}$ inches from outside to outside, and shall contain one Winchester bushel and one quart of water; and all coals chargeable with duties shall be computed by the chaldron, containing 36 bushels *heaped up*; and that a standard measure shall be made, and kept in the Exchequer."

Further, in the 43d year of his present Majesty's reign, it was enacted, "that the bushel shall be *heaped up* in the *form of a cone*, the outside of the measure being the extremity of the base thereof."

Neither of these acts, however, establishes a criterion to ascertain the *height* of the heap, which may be varied from 4 to 8 or 9 inches above the top of the measure. To this defect are to be ascribed the late nefarious practices in the admeasurement of coals, which for a series of years rendered the various laws made to protect the consumer perfectly nugatory; but this evil has of late been considerably remedied in wharf measure, by the introduction of Mr. Vazie's invention of a moveable *bow gauge* placed near the top of the established vessel, and with which the height of the heap is accurately and expeditiously defined.

The improvement is simply this: upon the outside of the legal bushel is placed a moveable iron semicircular bow, (much like the bail or handle of a pail), from the middle of which is suspended, on a loose joint, a pin, which forms a gauge. At the time of filling the measure, the bow and gauge lie on the outside of the bushel; when it is filled the base of the heap is circumscribed and accurately fixed by the bow, and the just height (7 inches above the top of the measure, as now fixed by the principal land coal-meters) is marked by coming in contact with the lower end of the gauge.

*Observation.*—The committee of the House of Commons, appointed for the consideration of the coal trade, have approved of Mr. Vazie's coal measure, and a bill has been presented to parliament this session, to establish the same for the admeasurement of all sea coals upon which duties are chargeable.

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*Description of a cheap Bedstead for a Workhouse, Hospital, or any of His Majesty's Barracks, Fever Ward, &c. &c. By Mr.* MATTHEW GREGSON.—*Rep. of Arts,* No. 48, *New Series.*

EACH bedstead rests upon two iron dogs of 13 inches high, and 40$\frac{3}{4}$ inches long, with rectangular indentations of a proper size to admit the ribs; these ribs are in number five, the three inner ones being each 4$\frac{3}{4}$ inches broad and 1$\frac{1}{8}$ thick when worked; the two outer ones, each 7 inches broad, but of the same thickness. All the ribs of 100 bedsteads (or any other number) are exactly alike, and all the dogs cast in the same mould; and the like care is observed in making the side pieces, which are wider, that they may have sufficient strength to sit upon occasionally. So that, admitting the head-board is fitted properly, and the holes bored by one gauge, which is easily done; any number of bedsteads may be taken down, washed, aired, or drest for vermin, if need be, and put up again, in as short a space of time as can well be conceived, by any person of a most ordinary capacity, without hammer, screw-driver, or other implement whatever.

Figures illustrating the parts of this bedstead are given in the number mentioned above of the Repertory of Arts, &c.

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*Explanation of Timekeepers constructed by Mr.* THOMAS EARNSHAW, *for which a Reward of three thousand Pounds was awarded by the Commissioners of Longitude. From the Communications made by him to the Commissioners.—Phil. Jour.* No. 54.

*Explanation of Timekeepers constructed by the late Mr.* JOHN ARNOLD, *for which a Reward of three thousand Pounds was given by the Board of Longitude to his Son, Mr.* J. R. ARNOLD, *Extracted from the Account delivered by the latter to the Commissioners.—Phil. Jour.* No. 55.

As it is impossible to give perspicuous descriptions of these truly ingenious specimens of mechanism independent of drawings, we shall rather choose to refer the reader, who is desirous to know the essential parts of the construction of these timekeepers, to the Philosophical Journal, for ample descriptions: at the same time we may extract, for the gratification of other readers, the

account given by each artist of his method of constructing the balance, with its compensation weights, &c.

In Mr. Earnshaw's timekeeper the balance is to be made of the best steel, and turned from its own centre to its proper size; then put into a crucible with as much of the best brass as when melted will cover it. The melted brass will adhere to the steel (a watch will not go well if any other metal is used for solder), then turn it to its proper thickness, and hollow it out so as to leave the steel rim about the thickness of a repeating spring to a small-sized repeating watch, turn the brass to twice or near thrice that thickness of steel, cross it out with only one arm straight across the centre, and at each end of the arm fix two screws opposite to each other through the rim of the balance, to regulate the watch to time; the diameters of the heads of these screws being about equal to the thickness of the balance. The compensation weights should be made of the best brass and well hammered, and a groove turned to let the rim of the balance into it, and this should be cut into fourteen equal parts by a wheel engine; then there will be had seven pairs of pieces of equal size and weight: two of these pieces being screwed on the rim of the balance at equal distances will produce an equilibrium, a complete balance. In making balances great care should be taken that they get no bruisings or bendings; for if they get a bruise on one side so as to indent the metal, that part will be less affected by heat and cold than the other parts which have not received the like violence to close their pores.

To adjust the balance in heat and cold, Mr. Earnshaw directs to put the watch into a temperature about 85 or 90 degrees of Fahrenheit, and mark down how much it gains or loses in twelve hours; then put it into as severe a cold as can be obtained for twelve hours; and if it gains one minute more in twelve hours in cold than in heat, move the compensation weights farther from the arm of the balance about an $\frac{1}{8}$ of an inch; but if it gains one minute more in twelve hours in heat than in cold, move the weights an $\frac{1}{8}$ of an inch nearer to the arm of the balance; and so on, in like proportion, trying it again and again till the watch is found to go the same in whatever varied temperatures it is placed. Mr. Earnshaw remarks that if a balance be in poise it will go nearly alike in all positions: if not, correct it by adding weights to the lowest part when in a losing position, if the same vibration be about 200°; if more degrees, then add weight to the upper part. Hence it is concluded that a moderate vibration is best. Mr. Earnshaw directs that the balance spring be made tapering, and observes that springs are, like animals, subject to a relaxation of force, which is regained by rest. Thus a loss on the rate is occasioned, which may be compensated by giving greater velocity to the shorter vibrations in the first construction.

In Mr. Arnold's construction the balance is screwed upon a collet fixed on the end of its axis; its two arms form one diametral right line, and at the extremities of these arms are two shoulders, against which are fixed the curved expansion or compensation pieces by two screws. These expansion pieces are composed each of two laminæ, the outside being of brass, the inside of steel: these pieces are made out of one, the brass being melted upon the steel in one piece. It is afterwards cut into two. The steel laminæ are continued, but made round, and tapped; and brass balls, or weights, alike in all respects, are made to screw upon each tap. In the sides of these balls are two holes between the centre and circumference made to receive a fork-screw driver to screw the balls higher or lower. There are two side screws which assist in making the balance of a uniform weight, and two screws one at each end of the original arms regulate the mean time, being tapped into the shoulders passing through the expansion pieces. The long and short vibrations being adjusted, Mr. Arnold shews his method of making the timekeeper perform alike in heat and cold. The balance spring becomes weaker by heat, and stronger by cold; and if the balance continued invariably of the same diameter, it would go slower in heat, and faster in cold, supposing it to go truly in a moderate temperature. But when the spring becomes weaker by heat, the expansion pieces move *towards* the centre of the balance, carrying with them the balls; so that the diameter of the balance becomes smaller, and relatively lighter. When the balance spring becomes stronger by cold, the contrary takes place: and when, after repeated trials, the balls are properly placed, the increase and decrease of the diameter of the balance will be proportional to the increase and decrease of the strength of the spring. The reason is this: the outside lamina of the expansion piece being of brass, and expanding or lengthening more by heat than the inside lamina of steel, to which it is attached, it will be easy to conceive how the brass forces the steel inwards; and as the same lamina of brass contracts or shortens more by cold than the steel, it is obvious that it must draw it outwards. Were the brass lamina placed inside, and the steel outside, the balance would expand or become larger by heat, and contract or become smaller by cold, and would add to the error of the spring instead of compensating it. This balance is adjusted to temperature by moving the little balls at the ends of the arms; and the adjustment for different positions is equivalent to shifting the centre of gravity towards that part which when highest gives the quickest rate.

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*Observations.*—These inventions have been the cause of some controversial discussion at the Board of Longitude, chiefly between the President of the Royal Society, who espoused the cause of Arnold, and distributed a printed protest against giving a reward

to Earnshaw; while the Astronomer Royal and the Professors of the two Universities, contended that the munificence of the Board should likewise be extended to Earnshaw.

Mr. Earnshaw's invention of the detached escapement was proved from the evidence of Mr. Robert Best, at the boards, of December 1, 1803, and March 1, 1804; and of Mr. Frodsham at the latter board. But Mr. John Brockbank's evidence of June 2, 1803, and March 23, 1804, only proves Earnshaw to have been the cotemporary inventor with Arnold, but independent of him.

The late Mr. Arnold indeed took out a patent for a detached escapement similar to Earnshaw's; yet Earnshaw always claimed the original invention, and made watches upon it, being never opposed by Arnold in that practice; nor did Arnold at the time boast of such invention, as it might have been expected from his warm disposition he would have done, had he been able to substantiate his claim to it. Nor did Arnold himself ever apply to the Board of Longitude for a reward for his invention; while Earnshaw has long claimed some reward for his invention.

On the third of March 1803, however, after the completion of the third trial of Earnshaw's two timekeepers at Greenwich, the Astronomer Royal having then as well as constantly before maintained at the Board that Earnshaw's watches had for the most part gone *better* than Arnold's, it was unanimously agreed by the Board to grant Earnshaw the sum of two thousand five hundred pounds, in addition to five hundred given him before; but doubts having afterwards arisen whether the merits of his timekeeper had not been over-rated, another board was called on the 17th of March to inquire into it; when, on examining various calculations made by the Astronomer Royal and Mr. Gilpin, and considering the accounts of the going of Mr. Earnshaw's watches, and those of others, the former minute was confirmed.

Indeed there could be no pretence for rewarding the invention of Arnold, and excluding that of Earnshaw (supposing them both to be *inventions*): for, without comparing the peculiarities of the two constructions, their different degrees of conformity to the stipulations of the acts of parliament were sufficient to decide. Now, it was shewn that the greatest errors of the best of Earnshaw's timekeepers in six months, in the last two trials at Greenwich, were less than the like errors in Arnold's watches, No. 36 and 68: the greatest error of Earnshaw's No. 1, in the second trial, being 3′ 43″, and of No. 2, in the third trial, was 2′ 47″; while Arnold's No. 36 gave an error of 4′ 20″, and No. 68, one of 4′ 39″.

Both artists, however, have at length, either in themselves or successors, experienced the rewards due to their ingenuity; and it is hoped that in future no such conduct will be pursued as will tend to obstruct and discourage the applications of ingenious men,

or to damp the ardour of other inventors, who may strike out farther improvements in contrivances of so much national and commercial importance as marine timekeepers.

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*Description of Mr.* TROUGHTON's *Magnetical Telescope.—Phil. Jour.* No. 56.

MR. Edward Troughton has constructed a new telescope for the determination of the magnetical meridian. It consists of a tube of steel, containing a set of lenses with cross wires or spider's webs, in the usual manner. An instrument of this kind, after receiving the magnetic power, may traverse upon pivots, or any other similar mode of suspension, and will dispose itself in the magnetic meridian. Mr. Troughton's magnetic telescope may be turned round in its support like that of the levelling instrument; and it will determine the magnetic meridian, whenever any one and the same object is seen upon the centre of the cross wires, after the telescope has been turned half round on its axis, as in its former state. By this contrivance the diurnal and the other variations, to which the magnetic bar is subject, may be easily observed, and it may even be ascertained whether the direction of the magnetic force varies with regard to the axis of the tube.

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*On Transit Instruments. By* EZEKIEL WALKER, *Esq.—Phil. Mag.* No. 96.

THE object of this communication seems to be, in part, the shewing that, in many cases, the old method of finding a meridian line by means of the sun's rays transmitted through a small circular aperture made in a piece of metal, may be applied without difficulty, in many situations that afford no foundation for a transit telescope; and, in part, the referring of those who want directions for the use of a transit instrument, to Mr. Wales's Treatise on the method of finding the longitude at sea, by timekeepers. But, as there is nothing in all this that bears the semblance of an improvement, invention, or discovery; this brief notice of the article is all which can be taken of it, by us, with propriety.

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*A Description of Mr.* GILBERT GILPIN's *improved Method of using Chains in Machinery, and of an improved Crane by the same Gentleman.—Trans. Soc. of Arts, vol.* 23.

MR. Gilpin has discovered a method of working chains of the common construction, over pullies, in all directions, so as to be more safe and flexible than the best hempen ropes, and less sub-

jected to retardation from friction. Every chain of the common form consituted of oval links has a twist in itself, arising from a depression given by the hammer to each link in the welding; whence the chain has, in consequence, a perpetual tendency (even when reefed perfectly straight on pullies, and on the barrels of cranes) to assume a spiral form, that is, the form of the threads of a screw, which a plain cylindrical barrel, and the common pullies with semicircular grooves, are not in the least calculated to prevent. Thus it happens that the alternate links of the chain, in coiling round a barrel, or working over pullies, form obtuse angles in assuming the spiral form, bearing upon the lower parts of their circumferences, and forming as it were two levers, which wrench open and crush each other in proportion to the weight suspended, as well as impede the motion of the machine by loading the chain with additional friction. A still greater obstruction to uniform motion is the tendency of the chain to make a double coil as it approaches the middle of the barrel and crosses its centre and that of the pullies at right angles; in consequence of which the chain is often broken by the sudden jerk caused by the upper coil slipping off the undermost.

As a preventive of these evils, which form the principal objection to the substitution of chains for ropes, Mr. Gilpin has screw-like grooves cast in iron pullies, of sufficient dimensions to receive the lower edges of the alternate links of the chain, the intervening links lying with their faces upon the face of the pulley above the grooves; a disposition of the parts which, if the grooves and face of the pullies are kept pretty smooth, must manifestly facilitate the communication of motion. The barrels are also of cast iron, with spiral grooves of the same dimensions at such distance from each other as to admit the chain to bed without the danger of a double coil; by these means the links are retained at right angles to each other, and the alternate ones slide along the groove into which their lower parts enter, the only position for free and uniform motion. When applied in blocks, brass guards with grooves opposite to those in the pullies, are rivetted to the blocks, to prevent the chain from getting out of its birth from any accident.

This method is applicable, at a trifling expense, to all machines now worked by ropes, or by chains in the usual way: and all the common chains now in use, may be adopted with nearly equal facility.

With a view of ascertaining the relative flexibility of ropes and chains when used in this new manner, Mr. Gilpin wedged an iron pulley 31½ inches in diameter, on the spindle of the pinion of a crane, whose barrel was 30 inches diameter, wheel 64 teeth, pinion 8 teeth, top block with 3 pullies each of 12 inches diameter, bottom block with 2 such pullies. He attached a small rope to

the large pulley, for the purpose of suspending the weights in the hoisting of the different loads, and the results were as follows :

| The crane was loaded with | Took to hoist the loads when reefed with the chain always in the same grooved pullies, | Ditto, when reefed with a half-worn tarred strand-laid rope $3\frac{1}{2}$ inch in circumference, | Ditto, when reefed with the chain promiscuously as in the common way, |
|---|---|---|---|
| lbs. | lbs. | lbs. | lbs. |
| First . . 2000 | 63 | 74 | 80 |
| Second 1000 | 32 | 39 | 41 |
| Third . . 500 | 17 | 21 | 22 |
| Total . 3500 | 112 | 134 | 143 |

The velocities being assumed equal in all the experiments, the comparative flexibility will be exhibited by the ratio of the weight and powers; whence appears the advantage of the new method; for, on the average of the trials, with the chain running in the grooves one pound raised 31.25 lbs.; with a half-worn strand-laid tarred rope $3\frac{1}{2}$ inches in circumference, 26.11 ditto; and with the chain in the usual way, only 24.47 lbs.

The other part of Mr. Gilpin's communication relates to the structure of the crane for hoisting goods. On reviewing the principles of stress in a crane, says this gentleman, we find that the gudgeons are the points of resistance to the machine and its load; and consequently the effect of the transverse strain upon the perpendicular will be proportional to the distance of the mortise for the gib from the upper one; and that of the oblique strain proportional to the distance of the mortise for the strut or diagonal stay, from the lower one. Hence results the necessity of skill and judgment in the distribution of the mortises, and the advantage of avoiding them altogether, if possible.

It appears, however, that the various parts of a crane formed of wood, cannot be connected together in any other way than by mortising; and as this method considerably diminishes the strength of the timber, Mr. G. makes use of cast-iron mortise pieces. The vertical part is formed of two oak planks, each 18 inches wide, 4 thick, and 16 feet long; these, at the top and bottom, are let into cast-iron mortise pieces, which keep the planks 10 inches asunder. The barrel for the chain works between them. The piece at the top contains in the middle a dove-tailed mortise, into which a stock for the gib is fixed; for greater security an iron bolt goes through the whole; the stock projects two feet from the mortise, and a plank 18 inches deep and 4 thick, is bolted to each side of it to form the gib, the interstice between the planks forming a birth for the top block to slide in. The diagonal stay is of the same dimensions, formed in a similar man-

ner, and connected to the vertical part by being let into the lower mortise piece.

In this mode of construction scarcely any part of the timber is cut away; and the strength of the materials, so far from being diminished, is augmented by the cast-iron mortise pieces; the gib is brought much closer to the upper gudgeon, and the centre lines of the perpendicular and the diagonal stay, crossing each other at the top of the lower one, places the whole strain as near as possible in a line with the gudgeons. The business of the vertical part becomes in consequence little more than that of a mere prop, and therefore requires no greater strength of materials than the diagonal stay. The top block is made of cast-iron, and has a groove 3 inches deep on each side for the purpose of embracing the planks which form the gib. To prevent the inconvenience of the dirt of the floor getting into the brass of the lower gudgeon, and thereby obstructing the revolution of the crane, those parts are in Mr. Gilpin's crane reverse to the common way, the gudgeon being fixed in the floor, and the socket part which embraces it is cast in the bottom of the mortise piece, as is also a channel to convey oil to the gudgeon.

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*Observations.*—Mr. Gilpin's ingenious expedient, by which the use of chains in machinery will be attended with less friction than is commonly experienced in the use of ropes, will naturally lead those who engage in the promotion of practical mechanics to inquire with some degree of precision into the comparative strengths of cordage and of iron chains, when stretched in the direction of their lengths. Mr. Gilpin adduces some arguments founded on theory to shew, that a chain running in grooves will sustain as great a weight when bent over a pulley, as it will in a direct line, while a rope has a much greater tendency to break in the former case than in the latter: hence he concludes that the chain will be safer than the rope, and he even affirms that the durability is at least six to one in favour of chains. We should like to be acquainted with the data on which this conclusion rests; for if it be the result of either theory or experiment, either the principles or the observations from which the inference was made might easily have been stated. The investigation is important and interesting; and whoever may undertake it will find reason to attend carefully to the circumstance, that in ropes, unless they are folded upon very small cylinders, the strain is equally diffused over a considerable portion, while in chains it will principally operate at those places where the links are constantly in contact, and where of course there will be a constant tendency to a rupture, by the wearing away of the material. If the experiments of Mr. Emerson may be relied upon, the strengths of good hempen rope and iron cylindrical bars of equal diameters, to resist fracture by stretching lengthwise, are as 22 to 135, or nearly as 1 to 6; but this ratio

must be received cautiously, since it is known that Mr. Emerson has assumed for the strength of ropes nearly double its actual magnitude. The following rule for judging of the weight which a rope will bear is not far from the truth, at least when compared with the experiments of Sir Charles Knowles: *Multiply the circumference in inches by itself and take the fifth part of the product, it will express the tons weight which the rope will carry:* we mean an untarred rope of a medium quality. But it has been established beyond a doubt that tarred cordage when new is weaker than white, and that the difference increases by keeping. M. Du Hamel decided by his experiments at Rochfort, 1st, That white cordage in continual service is one third more durable than tarred. 2d, That it retains its force much longer while kept in store. 3d, That it resists the ordinary injuries of the weather one fourth longer. Yet it has likewise been found that white cordage exposed to be very wet and dry, is weaker than tarred cordage: and that cordage tarred superficially is constantly stronger than what is tarred throughout, and better resists the alternatives of wet and dry. As to iron, although it seems more uniform in its strength than cordage of different manufactories, yet experiments, especially those of Mr. Banks, shew that there is a difference occasioned by different kinds of ore, and indeed a difference is often remarked in iron from the same furnace and the same melting. If to these considerations be added the effects of changes of weather, and particularly of exposure to humidity, upon iron chains; it will be seen that (even setting aside the consideration of relative expense, though that ought not to be forgotten) the inquiries suggested by this paper of Mr. Gilpin's are neither few nor trifling. The honour of turning them to good account must be reserved for some gentleman of leisure, judgment, and favourable opportunity; and our perusal of Mr. Gilpin's communication induces us to hope he will direct more of his attention to the subject.

With respect to the crane, its frame-work, and the disposition of its constituent parts, prove clearly that Mr. G. has closely contemplated the principles of strength, and stress of materials; and the inverted application of the gudgeons is an ingenious thought. But as to the mechanical advantage which the crane furnished, that does not seem to have been the contriver's peculiar object, and therefore ought not to be a topic of our censure, though it cannot be of our commendation.

*Description and Manner of using Mr.* ROBERT SALMON's *Geometrical Plotting Quadrant, Level, and Calculator, for the Use of Navigation and Land Surveying; ascertaining inaccessible Distances, and for demonstrating and determining various Problems in Geometry and Trigonometry.—Trans. Soc. of Arts, vol.* 23.

Mr. Salmon's quadrant has two rectilinear limbs moveable upon its centre, and capable of being set to include any angle between them, within the limits of a quadrant: these limbs are divided into six hundred equal parts (though the number is arbitrary), four hundred of which are equal to the radius of the quadrant: at the centre of the quadrant, or the common centre of motion of the two limbs, is an eye-piece with a small aperture in its middle, and at the farther extremities of the limbs are sights, which when intended for direct vision consist merely of upright rectilinear slits; but when objects are to be viewed by reflection the sights have each a mirror in their lower parts similar to the well-known contrivance in Hadley's octant. Supposing this quadrant to be held so that its centre shall be towards the left hand and the graduated arc towards the right, the radius of the instrument nearest the person is called, by way of distinction, *the base:* it has likewise a sight at its outward extremity, and is produced so as to contain more than five hundred of the equal parts of which the radius is four hundred: the other bounding radius of the quadrant need have no peculiar name: the rectilinear moveable limb which is farthest from the base is called the *upper*, and the other the *lower* limb. Close below the base of the instrument and in the plane of the quadrant, are a rack and pinion, by means of which and a nut, a right-angled graduated ruler (similar in shape to a common carpenter's square) may be moved either nearer to, or farther from, the centre of the instrument in the direction of the base. This moveable ruler is called a *perpendicular:* its longest leg, which is always retained in a position at right angles to the base, contains about six hundred of the equal divisions; the other leg, which during all its motion to the right or to the left, nearer to or farther from the base, is invariably parallel to it, may contain with convenience about two hundred divisions. At the back of the quadrant is fixed a spirit level in a direction parallel to *the base:* and Nonius's divisions are, or may be applied either to the arc, or any of the divisions on the limbs, &c. The quadrant is fixed to a staff by a joint at its centre or angle, so that its face may be placed horizontally, or obliquely, or vertically; and the lower end of the staff is shod, not with an iron spike in the usual way, but with a screw terminating in a point at the bottom like an auger; a contrivance by which the whole may be more firmly fixed in the ground, in the operations of surveying.

From the preceding description it must be pretty obvious that,

by means of the base line, perpendicular, and the limbs of the instrument, by the two motions of which the perpendicular (with its attached leg at right angles) is capable, the angular motion of which the limbs are capable, and the ease with which the angle between the two legs of the moveable perpendicular may be brought to coincide with any point on either of the limbs, any triangle either right or obtuse angled, may be constituted upon the plane of the quadrant. Hence this instrument may be of great use in constructing triangles from any usual given data, and measuring any of the required parts; or in determining with much facility, and without computation, inaccessible altitudes and distances: indeed it will be of considerable utility in solving a variety of important problems, such, for instance, as the following, enumerated and explained by Mr. Salmon:

1. To construct or set a triangle, having two of its angles and the sides between them given.
2. To set a triangle, having two sides and the angle included between them given.
3. To set a triangle, having two sides and an angle opposite to one of them given.
4. To set a triangle, having two angles and a side opposite to one of them given.
5. To set a triangle, whose three sides are given.
6. To measure an inaccessible distance, by a perpendicular line set off towards the right hand, from the line or base between the observer and object.
7. To determine the distances of any two inaccessible objects, both objects lying in a right line from the observer.
8. To measure an inaccessible distance in an oblique angle, where a right angle cannot be obtained by reason of some impediment on the ground.
9. To level, or measure, the altitude of any object.
10. To take angles or altitudes at sea, where the instrument cannot be made stationary.
11. To solve questions in proportion.
12. To find mean-proportionals.
13. To determine the inscribed or inscribing circle of any regular polygon, whose side is given.

These are the principal problems which may be solved by the aid of this instrument independent of any calculation: the methods of performing most of them are very simple and natural; and if one or two of them are operose, the methods may still serve as convenient substitutes when the preferable ones cannot be readily adopted. The modes of operation cannot be described here, without encroaching too much on our narrow limits.

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*Observations.*—There is undoubtedly much to commend in this invention of Mr. Salmon's. In many of the cases of measuring

inaccessible distances, it is far preferable to the dendrometer, or any other instrument we are acquainted with, that has been devised for the purpose of superseding the necessity of calculation; and it has the advantage of furnishing the requisite data for computation whenever the operator has leisure and inclination to examine into the nearness with which his instrument approximates to the results of a rigid calculus.

The quadrant is, however, susceptible of some improvements. 1. The joint of connexion between the quadrant and the staff should be placed at the centre of gravity of the former, instead of at its angle; an alteration which might easily be made without deranging its other parts, or making any farther change, except in the position of the spirit level: the instrument might then be placed steadily with more ease than it can now, when nearly all its weight acts on one side of the staff. 2. The arc might be extended beyond 90 to 120 or 130 degrees; and in that case it would be easy to construct an equilateral triangle upon the quadrant, a kind of triangle which furnishes, we think, the only exception to the universality of the instrument. 3. It would be advantageous to mark upon a concentric arc running just within the graduated arc of the quadrant, the halves of the natural sines of the angles regularly increasing from 0° up to 90°. For since by means of the instrument as now constructed, some two sides and the included angle of any triangle may be ascertained, and since by means of this additional graduated arc half the natural sine of any angle would be exhibited, there would be nothing required but to take the continual product of the two sides, and the half sine of their included angle, thus exhibited, to determine the area of the triangle; and that with tolerable accuracy, independent of the use of tables, except in the original construction of the instrument. Should Mr. Salmon peruse these observations, we trust he will receive the assurance as sincere, that they have been made, not with a view to carp at, but to improve, an instrument, the invention of which does him great credit, and which will doubtless be found extremely useful to such as do not possess either leisure or ability to perform some of the tedious and intricate calculations which frequently occur in practical trigonometry.

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*Description of an Apparatus for transferring Gases over Water, or Quicksilver, &c. By the Rev.* Gilbert Austin.—*Irish Trans.* Vol. x. 1806.

This apparatus consists of three pieces of plate-glass, the polish of which has been taken off by emery. The largest plate should be somewhat broader, and about twice as long as the dia-

meter of the jars used in collecting and transferring the gases. It has a hole about half an inch diameter, drilled through the middle of the plate. The second and third plate are not quite so wide as the first; they should both be cut off the same piece of glass, that they may be of the same thickness; and when joined together, they must be somewhat longer than the first plate: the second plate has a hole drilled through it near one end.

The jars used with these plates must have their edges ground upon a flat plate with fine emery. The gas being then collected in the jar, the first plate is laid close to the mouth, and then the second; so that the holes drilled through them do not coincide. The plates being moderately pressed upon the mouth, the jar thus closed is lifted out of the water, and set with the mouth uppermost. The jar into which the gas is to be transferred is filled with water, the third plate is pressed upon the mouth of it, and then being turned with the mouth downwards, must be placed upon the first plate, so that the edge may come in the strictest contact with that of the second plate. The hole in the second plate is to be filled with water, and then the two upper plates are slid over the first, so that the holes may coincide, and permit the gas to pass from one jar to the other. When a sufficient quantity has thus been transferred into the upper jar, the plates must be slid so that the holes may no longer coincide.

As the first plate is apt to rise from the mouth of the lower jar, it is best to fix it in a simple kind of frame. The same apparatus, upon a smaller scale, may be used with jars of quicksilver, as the joints of the plates retain quicksilver, provided the height is not more than three or four inches; and small jars hold quicksilver very well, when standing with their mouths downwards, upon ground plates of glass. It may indeed be so reduced in size as to enable the operator to perform all his experiments on gases confined by quicksilver, with about four or five pound of that metal; a frame in which the plates may slide being fixed to the mouth of the jar, which, being filled with quicksilver, is to be inverted in a small trough, to hold no more quicksilver than will just cover the frame, a small groove being made in the bottom, to admit a bent tube; and the quicksilver which descends out of the jar is permitted to run out through a channel in the side of the trough into a cup.

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*Observations.*—This is certainly an ingenious contrivance, as it saves the operator a deal of disagreeable dabbling in water, or continual immersion of his hands in quicksilver, which were unavoidable in the old method of transferring gases. At the same time, the construction is very simple, and exempt from the difficulties attending the formation and use of glass stopcocks.

It is evident that the plates may, in some cases, be advantage-

ously applied to the upper part of jars, employed in the collection of the gas in the first instance, and thus the incumbrance of a pneumatic trough may not only be entirely avoided, but the quantity of the gas ascertained to a greater degree of accuracy, by its being exposed to a small and known quantity of water. Thus let a jar open at top be put into a trough, with a groove in the bottom for the tube, and a discharging aperture in the side; if then the first and second plate be placed on the top, the common air in the jar may be transferred into another, and the jar in the trough filled either with water or quicksilver, without any inversion in the fluid. And this method appears to be, in particular, superior to the fitting of a frame to the mouth of the jar, as proposed by Mr. Austin.

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*On the Proportion of the several Gases which constitute the Atmosphere. By* John Dalton.—*Manch. Mem.* Vol. i. *New Series.*

In a former paper, "On the Constitution of mixed Gases," Mr. D. adopted such proportions of the simple elastic fluids to constitute the atmosphere as were then current: the principal object in that essay was, to shew that the repulsive power of each particle is confined to those of its own kind, and consequently the force of such fluid, retained in a given vessel, or gravitating, is the same in a separate as in a mixed state, depending only upon its own density and temperature.

The objects of the present essay are—

1. To determine what part of the weight of the whole compound atmosphere is due to each of its component parts.

2. To determine the relative weights of the different gases in a given volume of atmospheric air, such as it is at the earth's surface.

3. To investigate the proportions of the gases to each other, such as they ought to be found at different elevations above the earth's surface.

To those who consider the atmosphere as a chemical compound, these objects have only one answer; but upon Mr. D.'s hypothesis, they are totally distinct. 1. The density and elastic force of each gas at the earth's surface are the effects of the weight of that atmosphere of gas only, the different atmospheres not gravitating upon each other; and therefore it is necessary to find how much the given volume is diminished under the same pressure, by the abstraction of each of its ingredients only: thus, as it appears that by extracting the oxygenous gas from any mass of atmospheric air, the whole is diminished $\frac{1}{5}$ in bulk under the pressure of 30 inches of quicksilver, we may in-

fer that the oxygenous part of the atmosphere presses the earth with a force of 6 inches of quicksilver. 2. The weight of each gas in any given portion of atmospheric air, is in the compound ratio of its force and specific gravity: and, 3. The heavier the gases are, the quicker they decrease in density, as they ascend above the surface of the earth; so that, as Mr. D. observes, if the atmosphere had been of the same absolute weight as at present, but ten times as dense, no sensible portion of it could have arisen to the summits of the highest mountains, whereas an atmosphere of hydrogen gas of the same absolute weight would support a column of nearly 29 inches of quicksilver on the summit of Mount Blanc.

The gases known to be present in the atmosphere, are azote, oxygen, aqueous vapour, and carbonic acid. It is probable that hydrogen is also constantly present, but in so small a proportion as not to be detected, and therefore it is confounded with the azote.

The determination of the quantity of oxygen contained in the atmosphere by means of nitrous gas appears to Mr. D. to be not only the most elegant and expeditious of all the methods hitherto used, but also as correct as any of them, when properly conducted. Pure nitrous gas, nearly free from azote or nitrous oxide, may be obtained by pouring nitric acid, diluted with an equal bulk of water, upon copper or quicksilver, and taking care to apply little or no heat.

One hundred measures of common air, mixed with 36 of pure nitrous gas, in a tube only $\frac{3}{10}$ of an inch wide, is reduced in a few minutes to 79 or 80 measures, and exhibits no signs of either oxygenous or nitrous gas.

One hundred measures of common air, mixed with 72 of nitrous gas, in a wide vessel, over water, so as to form a thin stratum of air, will, on agitation, leave 79 or 80 measures of azote: if in this manner less than 72 measures of nitrous gas be used, the residuum will contain oxygen; if more, the residuum will contain some nitrous gas.

Hence it appears that oxygen combines with two proportions of nitrous gas; with an equal bulk it forms nitric acid, with twice the bulk it forms nitrous acid; and also that these two acids may be formed at the same time. The wider the tube, the quicker the combination is effected, and the more exposed to water, the greater is the quantity of nitrous acid, and the less of nitric.

Mr. D. thinks it most advantageous to endeavour to form the nitric only, by using a very narrow tube just wide enough to let air pass water without requiring agitation, and employing little more nitrous gas than is sufficient to form nitric acid. The residuary gas is also to be transferred as soon as the absorption has taken place into another tube, to prevent the nitric acid which

has been formed and combined with the water from absorbing the remainder of the nitrous gas.

Mr. D. allows that Volta's eudiometer is very accurate, and has found 100 measures of oxygen require 185 of hydrogen; on this account, he thinks that the specific gravity assigned to hydrogen is too small, since upon this ground 89 parts of oxygen would unite with only 11 of hydrogen, to form water, whereas 85 require 15: hydrogen ought therefore to be about $\frac{1}{10}$ of the specific gravity of common air.

From a consideration of the observations hitherto made, Mr. D. gives the following tables:

1. The azote contained in the atmosphere supports, when the barometer stands at 30 inches, — 23.36 inches

| | | |
|---|---|---|
| The oxygen | — | 6.18 |
| The aqueous vapour | — | .44 |
| The carbonic acid gas | — | .02 |
| | | 30.00 |

2. In a given volume of atmospheric air, taken at the surface of the earth, the weight of the azote is 75.55 per centum.

| | | |
|---|---|---|
| The oxygen | — | 23.32 |
| The aqueous vapour | — | 1.03 |
| The carbonic acid gas | — | .10 |
| | | 100.00 |

The proportion of aqueous vapour is variable in different places. It is probable that hydrogen is also constantly present in the atmosphere, but in too small a proportion to be detected by any test that we are acquainted with.

Berthollet seems to think that the lower strata of the atmosphere ought to contain more oxygen than the upper, because of the greater specific gravity of that gas, and the slight attraction it has for the azote; but Mr. D. is unable to conceive the possibility that two gases can be held together by attraction, unless their particles unite so as to form one gas, and, as upon his theory the atmospheres are independent on each other, their densities at different heights must be different according to their specific gravities. Hence if, on account of its superior mass, we take the azote as a standard, then the oxygen and carbonic acid gas will observe a decreasing ratio to it in ascending, and the aqueous vapour (whose specific gravity Mr. D. estimates at 0.700) an increasing ratio. On this supposition, the ratio of the oxygen to the azote on the summit of Mount Blanc, would be as 20 to 80, and therefore at any ordinary heights no perceptible difference can be observed.

*On the Tendency of elastic Fluids to Diffusion through each other.* By JOHN DALTON.—*Manch. Mem.* vol. i. *New Series.*

IT is well known that elastic fluids of different specific gravities being once diffused through each other, remain in a state of uniform and equal diffusion, and do not separate so that the heaviest is found in the lowest place. But Dr. Priestley thought that if two species of gas of very different specific gravities were put into the same vessel, with very great care to avoid the least agitation, they might continue separate. To determine this point, Mr. D. made the following experiments, which evidently shew that a lighter elastic fluid cannot rest upon a heavier, as is the case with unelastic fluids.

The apparatus he used in each experiment was two phials with perforated corks, connected by a tube, which was usually 10 inches long, and $\frac{1}{20}$ in bore; in some cases the tube was 30 inches long, and $\frac{1}{5}$ inch bore. In all cases, the heavier gas was in the under phial, and the two were placed at rest in a perpendicular position.

A pint phial of carbonic acid gas was connected by the 30-inch tube with an ounce phial of common air. At the end of one hour, the upper phial did not contain any perceptible quantity of the acid gas, but in three hours it instantly made lime-water milky. When hydrogen, azote, or nitrous gas was put into the upper phial, they became impregnated with the carbonic acid gas in half an hour.

Two 6-ounce phials were connected by 3 inches of the tube of a tobacco-pipe; the upper phial contained hydrogen, the lower one common air: in two hours the air in both phials exploded, on being tried.

Two 4-ounce phials were connected by the 10-inch tube; one contained common air, the other hydrogen: after two days the upper one was found to contain $\frac{1}{3}$ of common air.

Two 1-ounce phials were connected as before, and contained the same fluids: in $3\frac{1}{2}$ hours the upper was about $\frac{1}{3}$ common air: in another experiment, the two gases were found to be uniformly diffused through each other in 15 hours; and in a third experiment, when the under phial contained gas about $\frac{3}{4}$ oxygenous, the upper phial was in three hours $\frac{1}{5}$ oxygenous, and the lower about $\frac{1}{2}$.

The result of these experiments is, Mr. D. thinks, in favour of his hypothesis, that every gas diffuses itself equally through any given space, and that no other gas being in its way can prevent, although it may retard, this diffusion; and as chemical union cannot take place till the particles are brought into contiguity,

and the elastic force is diametrically opposite to chemical attraction, the circulation of elastic fluids is not accelerated by their having chemical attraction for each other.

Two 1-ounce phials were connected by the small tube, one being filled with nitrous gas, the other with atmospheric air: in three hours a diminution had taken place; but the two gases were nearly as pure as before; the portions that had met in the tube forming nitrous acid vapour, which was absorbed by the moisture in the phials. The same experiment was repeated with the same effect. Nitrous gas, and another, $\frac{2}{3}$ oxygenous, were tried; in four hours the gas in the upper phial was still $\frac{1}{2}$ oxygenous; the lower phial, owing to the gas from the upper one, which had been driven down the tube by the water when the apparatus was undone, was only azote, with a small portion of oxygen. With nitrous gas and hydrogen, in three hours the upper phial was $\frac{1}{4}$ nitrous. With nitrous gas and azote, in three hours the upper phial was $\frac{1}{5}$ nitrous. With azote, and a gas $\frac{2}{3}$ oxygenous, in three hours the upper phial was about $\frac{1}{14}$ oxygenous. With azote and common air, in three hours the upper phial was not diminished by nitrous gas, the under phial had lost $\frac{1}{10}$ of its oxygen, for the azote being contaminated with nitrous gas, this had united with all the oxygen that ascended into the upper phial.

In repeating these experiments, care must be taken that the inside of the tube is perfectly dry.

Mr. D. applies these experiments to explain Dr. Priestley's observations on the transmission of air into heated earthen retorts through their pores, while, at the same time, vapour passed out of them the contrary way; the one case in Mr. D.'s opinion differing from the other only in having a great number of pores instead of a single one of sensible magnitude.

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*On the Absorption of Gases by Water and other Liquids.* By John Dalton.—*Manch. Mem.* vol. i. *New Series.*

If water be boiled, or agitated in vacuo, nearly the whole of the gas it contained will be extricated from it.

Water thus freed from air being agitated with any gas, not chemically uniting with it, will absorb either its own bulk of the gas, or a part of it equal to some one of the following fractions: $\frac{1}{1}$, $\frac{1}{2}\frac{1}{7}$, $\frac{1}{6}\frac{1}{4}$, $\frac{1}{1}\frac{1}{2}\frac{1}{8}$, &c. these being the cubes of the reciprocals of the natural numbers 1, 2, 3, &c.; the gas being measured at the pressure and temperature with which the impregnation was effected. By experiment, it was found that the following is the bulk of each gas absorbed by water, the bulk of the latter being unity.

$1^{\frac{1}{1}}=1$. Carbonic acid gas, sulphuretted hydrogen, nitrous oxide.

$2^{\frac{1}{2}}=\frac{1}{2}$. Olefiant gas of the Dutch chemists.

$3^{\frac{1}{3}}=\frac{1}{27}$. Oxygen, nitrous gas (the error from the oxygen in the water being allowed for), carburetted hydrogen from stagnant water.

$4^{\frac{1}{3}}=\frac{1}{64}$. Azote, hydrogen.

Carbonic oxide gas is the only anomaly that has yet been found; of this gas water absorbs about $\frac{1}{36}$.

The water thus absorbed may be expelled in the same quantity, and unaltered.

Water free from air being agitated with a mixture of two or more gases, it will absorb the same quantity of each as if they were presented to it separately. Thus, as common air consists of 79 azote, and 21 oxygen,

| | | |
|---|---|---|
| Water absorbs $\frac{1}{64}$ of $\frac{79}{100}$ azote, equal to | - | 1.234 |
| $\frac{1}{27}$ of $\frac{21}{100}$ oxygen - | - | .778 |
| | Total | 2.012 per cent. |

If water impregnated with one gas be agitated with another gas equally absorbable, there will apparently be no absorption, but, upon examination, the residuary gas will be found a mixture of the two, and the parts of each in the water proportional to those out of the water.

If water impregnated with one gas be agitated with a gas less or more absorbable, there will apparently be an increase or diminution of the gas; but, upon examination, the residuary gas will be found a mixture, as in the former article.

The quantity of gas contained in water in an air-tight vessel, not near full, will remain the same in any temperature between 32° and 212°.

If water impregnated with one gas be agitated with another, having a chemical attraction for the former, the absorption of the latter gas will be greater by the quantity necessary to saturate the former.

Most liquids absorb the same quantity of gas as pure water, except they have a chemical attraction for it.

The purer kinds of water usually contain their due share of common air; if not, they quickly acquire it by agitation, and lose any other gas. Water, by stagnation, loses sometimes part or all of its oxygen, but the quantity of azote is not diminished by stagnation. Pure rain-water, in a stone-ware bottle, retained, however, its oxygen at the end of more than a year.

If water, free from air, be agitated with a small portion of common air, the residuum will have proportionally less oxygen than the original; so that water *apparently* absorbs oxygen in preference to azote.

If any gas be briskly agitated in water, it will gradually disappear, for, being divided into very minute bubbles, they are successively driven out from under the margin of the glass.

If old stagnant water be in the trough, and if it is common air that is agitated, a residuum of azote will be left; but if the water contains common air, the residuum will be unaltered in quality.

If any gas whatever be agitated over water, containing common air, the residuum will contain both oxygen and azote.

If water containing equal portions of two or more gases which are absorbable in different proportions be boiled, or agitated in vacuo, unequal portions of the gases will be expelled, that which is least absorbable being expelled in the greatest proportion, and the most absorbable in the least: those which are absorbable in equal bulk can scarcely overcome the cohesion of the water without violent agitation.

From the preceding facts, Mr. D. deduces the following theory of absorption:

All gases that enter into liquids by means of pressure, and are disengaged again by its removal, are only mechanically mixed with the liquid, and not chemically combined with it.

Gases retain their elasticity just the same in the liquid as out of it.

Each gas is retained in the liquid by the pressure of its own kind only, no other gas having any permanent influence on it.

When a liquid has absorbed its bulk of carbonic acid gas, &c. the gas does not press on the liquid, but on the vessel, as though no liquid was in it. When $\frac{1}{27}$ of oxygen, &c. has been absorbed, the exterior gas presses on the liquid with $\frac{26}{27}$ of its force, and on the internal gas with $\frac{1}{27}$ of its force, which force presses on the vessel, and not on the liquid. When a liquid contains no gas, its surface must support the whole pressure of any gas admitted to it, till the gas has, in part, forced its way into the liquid.

A particle of gas pressing on the surface of water is analogous to a single shot pressing upon the summit of a square pile of them.

When a liquid has absorbed $\frac{1}{27}$ of its bulk of any gas, the distance of the two strata of gas must be nearly 27 times the distance of the particles in the incumbent atmosphere, and 9 times the distance of the particles in the liquid; when $\frac{1}{64}$ only is absorbed, the numbers are 64 and 16.

An equilibrium between the outer and inner atmospheres can only take place when the distance of the particles in one atmosphere is the same, or some multiple of the other.

It is probable that the difference observed in the quantities of gas absorbable by liquids depends on the weight and number of the ultimate particles of the several gases.

The following table is given by Mr. D. as the result of his inquiries into the relative weights of the ultimate particles of bodies.

| | | | |
|---|---|---|---|
| Hydrogen | 1.0 | Nitrous gas | 9.3 |
| Azote | 4.2 | Ether | 9.6 |
| Carbone | 4.3 | Gaseous oxide of carbone | 9.8 |
| Ammonia | 5.2 | Nitrous oxide | 13.7 |
| Olefiant gas | 5.3 | Sulphur | 14.4 |
| Oxygen | 5.5 | Alcohol | 15.1 |
| Carburetted hydrogen from stagnant water | 6.3 | Nitric acid | 15.2 |
| Water | 6.5 | Carbonic acid | 15.3 |
| Phosphorus | 7.2 | Sulphuretted hydrogen | 15.4 |
| Phosphuretted hydrogen | 8.2 | Sulphurous acid | 19.9 |
| | | Sulphuric acid | 25.4 |

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*On Mr. Dalton's Theory of mixed Gases, and the State of Water in the Atmosphere. By Mr.* John Gough.—*Manch. Mem.* vol. i, *New Series.*

The intention of Mr. D.'s theory is to remove the difficulties which occur in Mr. De Luc's theory of atmospherical vapour; but Mr. G. imagines that even the present improvement, although ingenious, is liable to several objections, and that it is not only repugnant to the principles of the mechanical philosophy, but that some well-established facts contradict the essential points of the theory.

Allowing, for the sake of argument, the existence of such a mixture of gases, as is conceived by Mr. D. in which each gas exists as an independent being, and exercises the functions of its elasticity, just as if all other fluids were withdrawn from the common space; this systematic arrangement in an assemblage of gaseous substances cannot be maintained, unless one particular method of disposing its component parts be observed; which distribution of the elements must be such as will produce a separate equilibrium in the fluid composed of the elementary corpuscles of each denomination; consequently the equilibrium in question cannot take place unless the necessary disposition of the heterogeneous particles be first established; so that the former requisite of the theory is entirely dependent on the latter.

Mr. G. investigates mathematically the compa ative densities of constituent fluids on a horizontal plane, and demonstrates that when the component gases of a fluid mixture possess separate equilibriums, their densities are every where in a given ratio, and they have a common centre of gravity. On the other hand, if their densities be not every where in a given ratio, and if they have not a common centre of gravity, they do not possess separate equilibriums. But although the ultimate parts of the gases are, ac-

cording to Mr. D.'s theory, inelastic in respect to each other, the gases themselves are in the concrete, elastic. According to Mr. D.'s fundamental proposition, if two gases come into contact with each other, the particles of the one meeting with no resistance from the particles of the other, except that repulsion which they exert as mere obstacles in the way, would instantly recede from each other as far as possible, and arrange themselves as in a void space. But is it possible that such an arrangement can take place amongst the particles of two or more gases as will make their centres of gravity coincide in one point? When to any gas a portion of another is added, the separate equilibriums of the fluids cannot exist, and they will both obey the law of their specific gravities. As this contrariety of effects must continue as long as the two centres of gravity are disjoined, it must of course be lasting, as nothing can put an end to it but an union, which the action itself tends to prevent.

Nor can the mutual repulsion of the constituent particles of each gas, considered apart, promote in the least the junction of the centres of gravity of the two fluids, because the action and reaction of a number of bodies amongst themselves do not alter the state of their common centre of gravity, whether it be at rest or in motion, so that the two fluids would be under the necessity of observing the law of their specific gravities, just as if the particles of each fluid were not actuated by any reciprocal repulsion, or any other cause of reaction. Hence Mr. D.'s theory is rendered totally indefensible, for the very same reason as he assigns against the possibility of a mixture of mutually repulsive gases of different specific gravities.

It is certainly true, that the atmosphere is a compound of gases, and that different chemical agents perpetually disturb the equilibrium of the compound; and in consequence of the preceding observations, we may justly infer that they are united by chemical attraction. This mode of union appears also from the transparency of the atmosphere, since mechanical mixtures of bodies form opake aggregates, which are in many cases rendered transparent by fusion.

No one elastic fluid can maintain a separate equilibrium in any aggregate, as long as it makes an individual of that aggregate; consequently it is impossible for the aqueous part of common air to preserve the character of a gas at low temperatures, because steam cannot support 30 inches of quicksilver, unless it is heated to 212° Fahr.: were it therefore practicable to mix vapour of a less heat with atmospheric air, the spring of the gases would reduce it in an instant to the state of a liquid; so that the difficulty which originally rendered De Luc's theory objectionable, is not removed by the present modification of it.

The separate existence of vapour in the atmosphere is equally improbable, notwithstanding Mr. D.'s invention of the doctrine

of separate equilibriums; which he seems to think fully sufficient for that purpose, as nothing else has been offered in support of his opinion, unless we consider the statement of the following experiments as such. If two parcels of dry air, which are equal in all other respects, be confined in two equal tubes, one of which is wet, and the other dry, the air which is exposed to water will expand more with the same temperature than that which is kept dry. Upon Mr. D.'s theory, the vapour in the wet tube possesses a spring of its own, therefore it takes off part of the weight of the column of quicksilver from the air, which is thus enabled to expand itself still more. But if the expansion of the two airs, by being raised 59° in temperature, is computed by Mr. Schmidt's table, and that of the force of aqueous vapour be allowed for, as stated by Mr. D. it will appear that Mr. Schmidt must have operated when the barometer stood at 16 inches. If the two airs were raised 95° in temperature, then the pressure in Mr. Schmidt's table must have been only 8 inches. This difference is a presumptive evidence that Mr. D.'s theory is not absolutely just, provided Mr. Schmidt's and Mr. D.'s tables are correct.

According to the theory, the redundant vapour, if an exit for it is left free, ought to flow into the atmosphere, and thereby leave the moist air in the tube to follow the law of expansion belonging to dry air. But by experiment it was found that when a bottle having a dew sticking to the sides of it, was placed in water, whose temperature was 67° higher, for about two minutes, an occasional exit being allowed for the vapour and expanding air to escape, the actual expansion of the air was nearly double that of dry air.

This superior expansive power of moist air is capable of application to the origin of tornadoes and to the variation of the barometer. The atmosphere in hot countries is sometimes heated to 104°, which state is succeeded by violent falls of rain and hurricanes. Whatever may be the refrigerating cause, or that of the precipitation of the water, the air which is suddenly cooled 70° or more, and at the same time parts with its water, must lose much of its elasticity, and the destruction of the equilibrium may produce the hurricanes. The same causes probably give rise to the fluctuations of the barometer in milder climates.

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*On Mr. Dalton's Theory of mixed Gases. By Mr.* John Gough. —*Manch. Mem.* vol. i. *New Series.*

Mr. D. who is secretary to the Manchester Society, at the same time that he returned the thanks of that Society for the preceding paper, gave also his opinions upon the arguments contained in it, couched in terms of respect. Mr G. rejoined by the following remarks upon the several passages in that letter.

DALTON.—Gases mixed together, will be in a state of commotion, until they are uniformly diffused through each other; the centre of gravity of the fluids is out of the question, as the force of gravity upon any one particle is infinitely surpassed by its repulsive power.

GOUGH.—The centre of gravity is the true seat of the mechanical energies of all bodies, whether they be fixed, liquid, or aeriform; and therefore Mr. D.'s manner of arguing is rash, and contrary to the mechanical philosophy.

D.—I have not seen Mr. Schmidt's paper. If theory will in all cases tell how a man has made his experiments, we might infer some of his experiments were made on air of 15 or 16 inches pressure, and others on air from 8 to 5 inches pressure; but there is something wonderful in the quick transitions of some of his numbers.

G.—It is merely begging the question, to say Mr. Schmidt changed the pressure in his experiments. It is accusing him also of being unacquainted with the simplest doctrines of hydrostatics and pneumatics, although Mr. Kirwan has given a decided preference to his experiments on the elastic force of vapour. If he changed his pressure at all, he changed it frequently, but there is every reason to suppose he used the mean weight of the atmosphere.

D.—The experiment with the bottle of air and vapour agrees with the calculations of Colonel Roi, and Saussure, but is very different from that of Schmidt. There can be no doubt but that Schmidt's numbers are wrong. In respect to the inferences from this experiment, my expressions have been misunderstood. It has been thought that I supposed the particles of one gas, meeting with no repulsion from those of the other, would instantly recede from each other as far as possible, and *instantly* arrange themselves as in a void space; whereas my meaning is, that the particles of the one gas, meeting with no other repulsion from those of the other, than the repulsion which as obstacles in the way they may exert, would *instantly* recede from each other as far as possible in their circumstances, and *in the sequel* arrange themselves just as in a void space. Vapour certainly does enlarge the pores of air, without any necessity of having the force of 30 inches for that purpose. It does not require a force equal to their mutual repulsion to increase the distance of two particles of gas $\frac{1}{100}$ part, but only the $\frac{1}{100}$ of that force.

G.—Mr. D. has erroneously stated Mr. Schmidt's elastic force of vapour at 100°. Mr. D.'s style is too perspicuous to be misunderstood; he is therefore desirous of concealing an important change of sentiment, by charging his readers with a want of penetration; for he formerly stated (Manch. Mem. v. p. 580) the obstruction to the passage of vapour cannot arise from the weight of the atmosphere, *for then no vapour could arise under* 212°, but

it is caused by the vis inertiæ of the particles of air, similar to the obstruction which a stream of water meets with in descending among pebbles. But in truth upon his own theory, the least adventitious force that can enlarge the pores of a gas must somewhat surpass the pressure, which urges the particles of it downwards; now since this pressure on any particular particle, consists of the collective weights of all the incumbent particles, hence vapour which enters a gas, must overcome the force of gravity upon the whole fluid, so that it must acquire a boiling heat before it can effect an entrance. Mr. D. must therefore be content to rank with Mr. Pictet, and the other unsuccessful advocates of an aqueous atmosphere.

In the postscript, Mr. G. says, he has made some experiments which lead him to suspect Mr. Schmidt's accuracy.

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*Remarks on Mr. Gough's Essays on the Doctrine of mixed Gases, and on Prof. Schmidt's Experiments on the Expansion of dry and of moist Air by Heat.* By JOHN DALTON.—*Manch. Mem.* vol. i. *New Series.*

MR. G. refers more than once to the experiments of Prof. Schmidt, of Giessen, which have been freely quoted by Mr. Kirwan, in his Essay on the Variations of the Atmosphere (Irish Trans. vol. viii.). But as the results of his experiments, *as given by Mr. Kirwan*, differed remarkably from those of Mr. D. the latter was anxious to know the nature of his apparatus, concerning which Mr. K. had not given any information. Mr. D. therefore wrote to him for an explanation of it, and in the mean time ventured to assent (as has been stated in the former paper) to Mr. Gough's calculation, that Prof. S.'s experiments had been made with a pressure of 15 or 16 inches of quicksilver.

Prof. Schmidt having sent Mr. D. a copy of his Essay, the latter was surprised to find in it not a single trace of the table given by Mr. Kirwan, but another table on the expansion of moist air totally different, and calculated for every 10° of the hygrometer, and every 5° of Reaumur's thermometer. The correspondence between Prof. Schmidt's numbers and Mr. D.'s may be seen in the following comparative statement.

Table of the Expansion of one Measure of Air heated in contact with Water. = 0.9933 of dry Air.

| Temperature. Fahrenheit. | Reaumur. | Schmidt, as by his own work. | Dalton. | Schmidt, as represented by Kirwan. |
|---|---|---|---|---|
| 32° | 0° | 1.0000 | 1.0000 | 1.0000 |
| 43¾ | 5 | 1.0246 | 1.0257 | 1.0286 |
| 54½ | 10 | 1.0528 | 1.0531 | 1.0647 |
| 65¾ | 15 | 1.0804 | 1.0858 | 1.1045 |

| Temperature. Fahrenheit. | Reaumur. | Schmidt, as by his own work. | Dalton. | Schmidt, as represented by Kirwan. |
|---|---|---|---|---|
| 77° | 20° | 1.1120 | 1.1156 | 1.1528 |
| 88¼ | 25 | 1.1473 | 1.1538 | 1.2114 |
| 99½ | 30 | 1.1867 | 1.1997 | 1.6100 |
| 110¾ | 35 | 1.2316 | 1.251 | 1.98. for 33° |
| 122 | 40 | 1.2838 | 1.326 | |
| 133¼ | 45 | 1.3446 | 1.418 | |
| 144½ | 50 | 1.4166 | 1.548 | |
| 155¾ | 55 | 1.5023 | 1.73 | |
| 167 | 60 | 1.6198 | 2.01 | |
| 178¼ | 65 | 1.7872 | 2.50 | |
| 189½ | 70 | 1.9438 | 3.49 | |
| 200¾ | 75 | 2.1351 | 6.63 | |
| 212 | 80 | 2.3574 | Infinite. | |

The boiling point is taken by Mr. D. at 30 inches of the barometer; by Prof. Schmidt at 28 French inches, which is somewhat lower. It is evident that Mr. Kirwan committed an oversight in representing those numbers as Schmidt's.

Prof. Schmidt's apparatus was only a barometer tube, with a bulb turned up at the lower end, and having a communication with proper stop-cocks by means of which steam could be driven into the bulb, and made to expel the whole, or any part of the air. When this was done the apparatus was made air-tight, and immersed in water at 32°, the condensation of the steam left the inclosed air to support such a column of quicksilver as it was able. The whole apparatus was then immersed in water of any other temperature, and the rise of the quicksilver indicated the expansion arising from both air and vapour. The experiment he most relies upon is the following:

| Temperature. | Expansion of Air over Water. |
|---|---|
| 0° Reaum. | 15.88 inches, French measure. |
| 15 | 17.30 |
| 20 | 17.89 |
| 25 | 18.58 |
| 30 | 19.32 |
| 35. | 20.33 |
| 40. | 21.47 |
| 45. | 22.40 |
| 50. | 24.58 |
| 55. | 26.70 |
| 60. | 29.62. |
| 65. | 34.00. |

Above the temperature of 65° Prof. Schmidt seems to think that the force of steam in air is the same as the force of pure steam of the same temperature; but below that temperature, he

infers from the above table, compared with the expansion of pure steam, that steam mixed or combined (whichever it be) with air, has less force than when pure. This arises from his operating with a variable pressure, for if he had kept an uniform pressure at all temperatures, he would have found that the expansive force of vapour at any temperature is precisely the same when mixed with any kind of gas, as when pure. Indeed by his own method, it is evidently so at that point where the pressure was equal to 28 or 30 inches.

Prof. Schmidt has evidently supposed that the space occupied by any volume of air confined by water is inversely as the pressure; but a mixture of air and vapour is different, in regard to its elasticity, from dry air, because the space is not inversely as the pressure; for if a bottle of air be held with the mouth downwards for a few minutes in boiling water, on cooling the water it will ascend so as to fill almost the whole bottle, and there will not remain $\frac{5}{12}$ of the original air, as stated by Prof. Schmidt.

As to Mr. G.'s own arguments, they have all been answered in Mr. D.'s letter to him, quoted in the preceding paper. It is however evident from the conclusion of that paper, that Mr. G. did not understand the fundamental principle of Mr. D.'s theory. A particle of any one gas, actually in contact and pressing like an inelastic body on a particle of another kind of gas, does not prevent the simultaneous action of a kindred proximate particle, nor has any influence in modifying it, except so far as it might increase or diminish their distance. The mutual action of homogeneous particles resembles magnetic action, which is not affected by whatever other action takes place, or whatever other body intervenes.

# AGRICULTURE.

*Comparative Experiments on the Cultivation of Potatoes, at Kilcalmonell, &c. in Scotland, in the Years* 1790 to 1805. *By the Rev.* ALEXANDER CAMPBELL.—*Farmer's Mag.* No. 26.

AN abstract of the results of this valuable course of experiments, during the first five years of the above period, was, we are informed, laid before the Bath Society, and published in their 9th volume of Papers. The object of these experiments has been to discover, whether it was more for the interest of the farmer to plant potatoes large or small, whole or in pieces, and to ascertain the distance at which they should be set. In 1790, 1791, and 1792, the rows were 3 feet, and, in 1794 and 1795, $2\frac{1}{2}$ feet asunder; the distances at which the potatoes were planted in the

row, were measured by a stick with notches, and taken from the centres of the potatoe sets. Care was taken to have the rows as equal in quality of soil as possible, and to have equal justice done in manuring, where manure was applied, as also in horse and hand hoeing them. The quantity planted and raised was noted in the field, and every part of the process of management was superintended by the Rev. Mr. *C.* himself. The English acre of 4840 square yards was used; therefore of rows 3 feet asunder 4840 yards in length went to the acre, and of 2½ feet rows 5808 yards in length: the quantities were ascertained in bolls and pecks (Linlithgow measure), and pounds, Amsterdam weight; 19 pounds being = to 1 peck, and 16 pecks = to 1 boll. In most of these five years experiments, the produce from *pieces* of potatoes was inferior not only to *large*, but to *small whole* potatoe sets; yet, in general, the pieces exceeded the small potatoes in weight of seed set. The productiveness of potatoes is probably occasioned, not so much by the weight or quantity of the sets planted, as by their having that number of fibres or roots, which the soil they feed in can bring to perfection. Pieces of about 2 oz. in weight and whole potatoes from 2 to 1 oz. in weight, are, when set 12 inches distant in 30 inch rows, perhaps the best adapted for the average of soils: the paring hoe-plough can be used with effect, and the hand-hoe between the plants. Where potatoes are subject to the curl, small sets should not be planted; a disadvantage of planting *shoots* instead of potatoes is, that their produce do not ripen so early, and are therefore more apt to suffer by autumnal frost, and being more delicate they cannot be planted so early as sets can, without fear of injury from the cold: their produce is also less certain than that from potatoe sets. Potatoe stems ought never to be cut, at any period of their growth, but suffered to decay, till which time the crop will continue to improve; but the same becomes stationary immediately after the tops are cut off: cattle ought by no means to go among potatoes.

The Rev. Mr. C. having been informed of the practice of the Rev. Mr. Cook and Mr. Crook of Wiltshire, in scooping out the eyes of potatoes for planting in the year 1795, instead of sets, in the following years he repeated this experiment, and found that the produce from scooped eyes, consisted of a greater number of large and fewer small potatoes, than by any other method of planting: having observed, that in the top of the small end of each potatoe, there is an eye which discovers a tendency to grow sooner than the other eyes, and more vigorously; a row entirely of these principal eyes was planted, and proved much superior in produce per acre to the others; the potatoes were also larger than common: in others of the experiments, about one third or less of the top end of each large potatoe was cut off, including the principal eye, for setting; the clear produce was equal to that from whole middle-sized sets, and the weight of sets used, not more than one

half. The experiments were made with eyes and pieces, newly separated at the time of planting them, and with other eyes and pieces preserved (according to the method of Messrs. Cook and Crook) for three months, in an open box with a portion of chaff sufficient to keep them from drying by the air or heating by closeness, kept in a place not exposed to frost or great heat: very few of these last perished, and there was no apparent difference in their produce from the fresh scoops, or top-ends. Potatoes deprived of their top-ends, and consequently of the greatest number and earliest growing of their eyes, were found easier to keep in condition for eating through the summer than whole ones.

Future experimenters and authors are cautioned against taking the *return of seeds* as a criterion of the productiveness of a crop of potatoes, instead of reducing the same to acreable produce; and reference is made to table III. of the experiments, where 2 lbs. of principal eye-scoops produced 200 lbs. of potatoes, or 100 lbs. from 1; while in the adjoining row 29 lbs. of middle-sized whole sets produced 240 lbs. or only $8\frac{1}{3}$ from 1! Part of the potatoes were raised without dung, upon lands which had previously borne turnips, which were not fed off on the ground, but pulled and carted home for stall-feeding. In 1796, an acre of land for potatoes was manured with newly dug peat-earth, placed under the potatoes in the rows: the produce was $14\frac{1}{2}$ carts (a measure of 16 Kintyre pecks, each of 48 lbs. Amsterdam), while a contiguous half acre manured with dung, produced 10 such carts of potatoes. Mr. C.'s horses during a considerable part of the season were fed with potatoes, instead of oats.

In order to secure greater accuracy, the experiments in 1799, on eight kinds of sets, were five times repeated in alternately successive order (i. e. every 1st, 9th, 17th row of one sort; 2d, 10th, 18th row of another sort, &c.) in rows of 5 yards long *across* a ridge or land, the ploughing and manuring of which had been performed lengthwise. Mr. C. states, as the results of his observations on the disease in potatoe crops, called the *curl*, that the produce from curled plants are generally smaller than from healthy plants, and that such, if used for seed, are apt to produce the curl in the future crop: for obviating which, he recommends scooping the eyes from the largest and finest potatoes, or cutting such up with an eye in each, and carefully to mix the cuttings or scoops together before the planting is begun; and in performing this operation, to set or drop three cuttings or scoops in each hole: by which procedure, as the chances will be greatly in favour of having at least one healthy plant in each hole, the luxuriant growth of the same will soon occasion them to overpower and smother the curled stems, from the diseased sets that may accidentally be used: these curled stems he directs to be treated as weeds, and to be pulled up or cut off, as entirely useless. The additional expense of seed in planting three cuttings, or small healthy whole potatoes with that number of eyes at least, will be

amply compensated in the future crop. We regret our inability, for want of room, to give the tables of results, in the judiciously varied experiments here recorded: it may however be proper to state, that of twenty-seven acreable products which are given, the three highest are as follows, viz. 1st, In soil saturated with dung, from middle-sized whole sets, 12 inches asunder in $2\frac{1}{2}$ feet rows, the produce was 91 bolls, 11 pecks, and 3 lbs. 2d, In the same soil and circumstances as the last, except that the sets were top-ends less than $\frac{1}{3}$ each of the large potatoes from which they were cut, the produce was 90 bolls, 2 pecks, and 14 lbs. And 3d, In rich soil at Edinburgh, rows $2\frac{1}{2}$ feet asunder, manured with 38 tons, 18 cwt. nearly of dung per acre, the produce was 81 bolls, 3 pecks, and 3 lbs.

The three lowest produces recorded are, 1st, In poor soil, rows 5 feet asunder, manured at the rate of about 19 tons, 9 cwt. of dung per acre, the produce 22 bolls and 11 pecks. 2d, In similar soil and alike manured and managed with the last, except that the rows were $2\frac{1}{2}$ feet asunder, produce 32 bolls, 3 pecks, and 16 lbs. per acre. And 3d, In rich soil at Edinburgh, rows $2\frac{1}{2}$ feet asunder, without dung, the produce 38 bolls, 3 pecks, and 7 lbs. per acre. The mean calculated produce of these 27 experiments we find to be 60 bolls, 14 pecks, and 16 lbs. per acre: the two nearest to and exceeding this average, were, 1st, From small whole potatoes planted upon dung, 12 inches apart in $2\frac{1}{2}$ feet rows, produce 63 bolls, 12 pecks, and 16 lbs. And 2d, From middle-sized pieces of large potatoes, planted as last, produce 63 bolls, 15 pecks, and 17 lbs. The two nearest experiments less than the above average, were, 1st, From bottom-ends of large potatoes, planted as in the two last-mentioned experiments, the produce 53 bolls, 13 pecks, and 18 lbs.; and 2d, From small whole potatoes, planted in $2\frac{1}{2}$ feet rows, without dung, on land which had previously borne turnips that were carried off, produce 56 bolls, 14 pecks, and 15 lbs. per acre. Mr. C.'s concluding remarks are, that the occupier of poor land, where the value of the produce is small, should, though limited in his means of providing manure, apply that article very liberally to his potatoe crop; while the fortunate possessor of rich soil, who at the same time obtains good prices for the produce, may find it to be his interest to manure more sparingly and crop more land. Two and half feet rows are found superior to five feet rows in produce, both on rich and poor land. Five feet rows, however, admit of deep ploughing in the intervals, to destroy root-weeds, and will prove a better substitute for a summer's fallow.

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*Observations.*—Our readers will find in the long tables of results given by the Rev. Mr. C. much curious and useful matter for reflection and calculation, on the most economical and productive methods of cultivating this highly useful root.

*On the Uses of Potatoes in feeding Cattle. By Mr.* THOMAS ROBERTS.—*Young's Annals*, No. 259.

THIS gentleman cultivates potatoes on a large scale, as part of a three-years system or rotation of crops, viz. potatoes, wheat, beans, potatoes, &c. and steams them for the use of his cattle. He says in substance as follows:--" My oxen and wether sheep were all sold *completely* fat, by the 20th of March, 1805: the oxen paid me rather more than 11*d.* per bushel for the potatoes, and the wethers exactly 13*d.* My fatting swine with steamed potatoes, rather disappointed me: to *a certain degree*, perhaps rather more than half fat, they improved rapidly, after which, although they still ate their food well, they advanced very slowly: after a month's trial had satisfied me, that their food was not forcing enough, I added to each steamer, containing 7 bags or 14 cwt. of potatoes, two bushels of barley-meal and 2 bushels of pea-meal, mashing the whole well together. The pigs now throve kindly, but still they did not seem thirsty or hot enough to be advancing in the quickest manner I therefore, after ten days, added to each 14 cwt. of potatoes, 6 bushels of barley-meal and 6 of pea-meal, which answered all my expectations; and, in three weeks after beginning this last food, I sold to Mr. Westgarth, of Gosport, ninety-three hogs, weighing on an average ten score and fifteen pounds. In this way I do not think the potatoes paid more than 8*d.* per bushel. My potatoe-fed oxen, sheep, and swine all *proved* so well, that I have not had a single complaint from any one of the various butchers who have been my customers, but they uniformly come again to purchase of them. Potatoes now (Feb. 1806) fetch only four shillings per bag, or one shilling less than last year; yet my crop is so much larger, that, besides supporting my stock, I have sold to the amount of near three hundred pounds."

*Observations.*—The profits derived by Mr. *Roberts* in the application of his potatoes to the fattening of cattle, will, we hope, prove a stimulus to a more general cultivation of them by farmers *. We have frequently known of large quantities of potatoes, grown among young plantations, disposed of at no more than 6*d.* per bushel, in plentiful years; when it is probable from the above, that double that sum might have been made of them in feeding cattle. The spring-sowing of wheat after potatoes, is stated to have succeeded well in the southern parts of England.

* See also, our 1st volume, page 276.

*On the Culture and Management of Potatoes as a Substitute for Flour. By Messrs.* NEHEMIAH BARTLEY *and* JAMES BRIGHTLEY.—*Agricultural Mag.* No. 81, 82, *and* 83.

MR. Bartley states, that from long observation, and the concurrent testimony of many poor cottagers, whose families have sometimes been compelled to subsist entirely on the potatoe, he has good reason to conclude, that a sack or 2 cwt. of potatoes is equal *at least* in nutritious effect, to a bushel or 62 lbs. of wheat: that potatoes consist of water, fibre, and farina; that owing to the different proportions of the latter substance, in different sorts of potatoes, some sorts will yield one forth of their weight of farina, while the general average from those sorts in common use may be but one fifth, or 45 lbs. from the sack of potatoes: the most mealy sorts being nearly three fourths composed of water, and the most inferior perhaps of more than seven eighths: that a gallon of potatoe flour is nearly 2 lbs. heavier than the same measure of wheaten flour, and weight for weight the former is considered by him as much more valuable and efficient than the latter: that the particles of potatoe flour are not sufficiently adhesive alone to make bread, but with one part of wheat flour, added to two of potatoe flour, good bread may be formed.

In 1795, a loaf composed of equal quantities of potatoe and wheat flour was sent to and approved by Lord Sheffield, on the fifth day after baking: that potatoe flour appears to be of the nature of orchis root and salop, containing a great quantity of nutriment in a small volume; about an ounce weight of it, formed into a bouillie with milk, would prove a good breakfast: it is also presumed that a judicious preparation of potatoe flour would be the most profitable in the fattening of animals, swine in particular. Mr. Bartley calculates 75 sacks of potatoes and 25 bushels of wheat to be fair average crops of each, and concludes that an acre of good potatoes would be worth three acres of wheat; as the best or mealy sorts, are found to the full as productive as the inferior kinds: the wheat crop occupying the ground for an entire year, whereas early sorts of potatoes might be selected, which could be taken from the ground in July, affording time to sow tares or vetches as winter or spring feed for sheep. Mr. Bartley disclaims the idea, of recommending potatoes to be cultivated to the dimunition of our produce of wheat, and states his chief aim in the above remarks to be, the removing of the principal existing impediment to an enlarged cultivation of potatoes, viz. the want of a mode of preserving the surplus of the annual consumption, beyond the period of the year. This from experiment, he conceives, can alone be effected by separating the flour from the bulbs, which by a suitable

apparatus, might be easily done in the large way: and that in tight casks potatoe flour might be preserved perfectly sound, for a great number of years, certainly much longer than wheaten flour: potatoe flour, rather carelessly kept in a common sack for more than two years, was yet found as sweet and sound as ever, and perfectly fit for use in puddings, &c. The proportion of fibre contained in potatoes, varies from one fifteenth to one twentieth of the bulb, and is an article capable of being wrought into paper: the water of the potatoe is thought to be noxious. Mr. Bartlet states the prices of potatoes during his practice as a farmer, to have varied from one to twelve shillings per cwt.: at the former price he once delivered near one hundred tons, at three miles distance, while greater quantities remained unsaleable even at this loseing price: twelve working Devon oxen, fed on these and sweet barley straw, improved greatly during the winter and early part of the spring.

Mr. Brightley maintains, that the high encomiums bestowed by Mr. Bartley on potatoes, have a tendency to lessen the cultivation of wheat, the now grand desideratum of British husbandry: that an acre of land applied to the culture of potatoes, can only for a limited period remain equal in value to three acres of wheat, if potatoes were cultivated on so much larger a scale as supposed: that the early sorts of potatoes are so decidedly inferior in nutritive qualities to the later ones, as to be more proper for the purposes of the gardener than the farmer: that on account of the expense and trouble of separating the farina, the baking of potatoes is likely to prove more advantageous, by which they may be preserved sound and sweet for many months: that the inferior kinds of potatoes are almost void of any nutritious qualities, and even impart a debilitating and noxious effect, and yet, through indolence and ignorance, these well-known inferior sorts are cultivated.

Mr. Brightley states, that potatoe flour is inapplicable to the purposes of hair-powder on account of its weight; that potatoe starch is wretched, meagre, unsubstantial stuff, compared with the starch produced from wheat, and that wheat must be at an immense price indeed, to render it eligible to manufacture starch from potatoes instead of it: in the distilleries, potatoes have not been able to keep their ground, not even in their most plentiful years: that pork fed with potatoes, or even with an admixture of potatoes with corn or milk, is inferior in weight and taste, to pork, otherwise fed: that potatoe flour has a cooling and laxative effect on animals who eat it, while the orchis root is warm and astringent; that salep is probably in part composed of potatoe flour: that the want of adhesion in potatoe-flour bread, shews its inferiority to wheaten flour: that the best wheaten bread is uniformly preferred by labourers, for its flavour, but more for its stay in the stomach, and imparting a superior ability to continue

labour, over all the substitutes which have been proposed: that though Irishmen are said to live chiefly on potatoes, yet such as come here, can all labour in proportion to the substantial goodness of their keep, and that during the late scarcities the weakening effects of potatoe diet were visible on our labourers: that potatoe flour and milk for breakfast would only make a person more hungry at dinner, and that the cheapest food for labouring servants is solid pork or beef, and beer "not guiltless of malt."

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*Observations.*—We are truly concerned to observe some of our best writers on practical agricultural and rural subjects, continuing still ignorant of chemistry, while a large portion of them are found treating this essential branch of knowledge, on all occasions, with sovereign contempt. By both of the above writers, potatoe *flour* is confounded with potatoe *starch*; and the latter, when deprived of its soluble or mucilaginous parts, is compared with wheaten flour, instead of the starch of wheat, to which it bears a nearer resemblance. The process of obtaining the flour of potatoes by boiling them in their skins, drying them on a kiln, and grinding them in a steel corn-mill, as described in the following article, seems to offer a better mode of preserving this valuable substance for general use, than Mr. Bartley's above. That some mode for this desirable purpose is wanting, is apparent from the circumstance, of there being almost regularly an alternate dear and cheap year for potatoes, in the interior parts of the country: the high prices of dear or scarce years stimulate numbers to plant largely, by which the price in the spring is inordinately advanced; next autumn the supply exceeding the demand, and no method being in use to preserve the article, the price falls so low, that great numbers lose by their crop, and are deterred from planting at all next year. That potatoe starch is inferior to wheaten starch for the purposes of the laundry, as the same has hitherto been prepared by the housewives themselves, is admitted, principally on account of its rendering the linen yellow; but that this property might be removed, on a more extended use of the article, so as to induce scientific manufacturers to improve the processes, can hardly be doubted. The water into which potatoes are grated is not quite so useless as Mr. Bartley supposes above, but, from the discovery of Mrs. *Anne Morris* (see Transactions of the Society of Arts, vol. xxiii. just published, and which will be noticed in our next number), the same seems applicable to the cleaning of dirty silk, woollen and cotton goods, paintings, prints, &c. and perhaps to other purposes in the arts.

*Remarks on sundry important Uses of the Potatoe.—Bath Papers*, vol. x.

Experiments on a large scale were made by the anonymous author of this paper. Potatoes were boiled whole with their skins on, dried on a kiln, and the whole ground in a steel mill, without separating any of the skins in dressing: this flour was found to keep longer at sea than wheat flour: it has been used as a substitute for sago, and for making biscuits without mixture. The chief labour is in washing the potatoes from the mould which adheres to the eyes, particularly in those sorts the eyes of which are much depressed. An average crop of potatoes is estimated at 80 sacks of 240lb. each per acre; and 100lb. of washed potatoes will produce 25lb. of dry flour, making a produce of two tons and upwards of flour per acre. The sort used in these experiments was the red apple potatoe. In another experiment, the washed potatoes were steamed, bruised slightly, and then dried on a malt-kiln, after which they were ground in a common corn-mill, set as for wheat flour: only a few pieces not ground, and a small quantity of bran, were separated. Bread made from this flour, rose well in the oven, but fell again when the oven door was opened. The chief precaution necessary in making potatoe-flour is, to prevent any fermentation taking place in the boiled potatoes previously to their being dried, and to avoid giving them too great a heat in drying, the heat should seldom exceed 90°. For the common purposes of bread, taking off the rind or skin from the potatoes is by no means necessary, but they must be well washed. Potatoe flour, barrelled up and kept in a dry place, seems almost imperishable. Potatoes kiln-dried and packed in barrels, either whole or cut into parts, may be kept for the use of the table in long voyages, and are capable of being again boiled soft when wanted for use.

*On the Storing of Turnips. By a Norfolk Farmer.—Farmer's Mag.* No. 26.

After stating the objection which the good farmers of Norfolk feel, to drawing and carrying off their turnips to be stored, and detailing the method lately practised by Mr. *John Repton* (see our 1st volume, page 298), this writer asks, might not this practice be still further extended? why not draw the crop, in dry weather, from those lands where poaching, by carrying them off in wet weather, would be so unquestionably detri-

mental? and why may not the dryest fallows, intended for turnips the following season, be prepared to receive them when thus drawn, and the crop be secured in trenches, as proposed? If fed upon the land where they are deposited, it will be enriched; if carried off the field, it will be in no worse condition; and the difference of expense between this and other methods of storing cannot be considerable.

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*Observations.*—The hints given above may have their use to a limited extent, in some situations, but the plan has its obvious disadvantages: few practical farmers will approve of fallowing land, after it has been richly manured by the feeding off of a crop of turnips, instead of taking a crop of barley; and equal objections will, in most cases, lie to the sowing turnips after others have been fed off.

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*On preventing Ruta Baga or Swedish Turnips from shooting.*—*Farmer's Mag.* No. 26.

On a loose sandy soil, on the borders of Loch Fyne, in Scotland, the writer cultivated Swedish turnips, by transplanting them from a seed-bed in June or July. About three roods thus planted in the middle of June 1805, shewed in August a strong disposition to shoot, which became so general in September, that the design was entertained of immediately consuming them by the milch cows, but they refused them at that season. Several of the plants were nearly in flower, and fifteen out of twenty of the whole certainly would have done so, when it occurred to the writer to cut off the stems about an inch or two above the crown of the bulb, which from that time began to enlarge rapidly; but towards the latter end of September and through October, the stumps threw out innumerable shoots having a tendency to flower: the greater part of these were broken off from time to time, until the first week of November, when the crop was drawn and housed; some of the bulbs weighing 7½lb.; the average weight probably 4 to 5lb. From the time of housing until the period of writing, January 1st, half a dozen early-calved cows, and some other cattle, were fed upon them, and some were regularly used at the table, without being able to discover any deficiency in the quality on account of the bulbs having shot. In 1803 several Swedish turnips, grown in moss-land, near the borders of the Loch, were found to weigh 8 and 9lb.

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*Observations.*—In unfavourable situations for early cleaning of the land intended for Swedish turnips (which require to be sown very early), the practice of transplanting may be adopted with

great success; and when the seed-stalks, from this or any other cause, begin to shoot up in the autumn, it may be of considerable importance to adopt the method above pointed out, in an early stage of the mischief.

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*On laying down Land for permanent Pasture. By an Essex Farmer.—Agric. Mag.* No. 82.

This writer, after stating that the old plan of sowing rye-grass and clover only, or Yorkshire or London hay-seeds, never produced a capital meadow, on the experience of four years, upon good dry loam, and also on light soils inclining to be sandy, recommends, for this last, the following mixture of seeds, which may be had clean, and in perfection, of Mr. *Gibbs*, seedsman, in Piccadilly, London—viz.

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| Improved perennial rye-grass, | | *lolium perenne,* | half a bushel. |
| Cocksfoot, | — | *dactylis glomerata,* | ditto. |
| Crested dog's-tail, | — | *cynosurus cristatus,* | 4lb. |
| White clover, | — | *trifolium repens,* | 5 |
| Trefoil, | — | *medicago falcata,* | 3 |
| Burnet, | — | *poterium sanguisorba,* | 4 |
| Yarrow, | — | *achillea millifolia,* | ½ |
| Rib-grass, | — | *plantago lanceolata,* | 3 |

The yarrow is stated by this writer to be far inferior on his soil to the other plants, and might be omitted with advantage. On poor soils he would substitute spurry *(spergula arvensis)*, if the seed could be obtained; it being a plant in high repute on the barren sands of the continent, and said to be very productive of milk in cows. After thoroughly cleaning the land by a summer's fallow, the seeds are recommended to be sown towards the end of August, without any corn crop.

*Observations.*—We should be inclined to omit the three last plants in the above list, the rib-grass in particular, for the reasons given in our first volume, page 285. In these we find ourselves confirmed by Mr. *John Carpenter*'s communication in the above number of the *Agr. Mag.* who recommends for light land, one bushel of heavy rye-grass and 8 or 10lb. of white Dutch clover per acre, to be sown in July or the beginning of August, on a clean fallow, without corn.

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*On the Improvement of Grass-lands in Gloucestershire. By Mrs. E. G.—Annals of Agr.* No. 259.

We are here presented with the rare instance of a Lady undertaking and directing agricultural improvements. She says—"I

bought a small estate, and took possession of it in the month of July 1803. I mowed the crop immediately, and had only nine ton of hay off 15 acres, and it was so full of weeds, rushes, mint, &c. that my horses would not touch it. I found the land not only poisoned with springs, but full of great rocks lying above ground, and partly covered with thorns, orles, old stumps of trees, &c.: added to this, there was scarcely the vestige of a fence. I had the rocks blown up, broken small, and laid in the drains: all the trees grubbed up. I had 576 perches of under-drains made, and as much open ditching, besides a large ditch under every hedge. I grubbed close to the hedge-rows, and sowed hay-seeds. This work was all concluded, and the ground cleared, by the end of March. In July following, I mowed the 15 acres, and had 30 tons of hay, *all of the best herbage*. The next winter (1804) I dressed the land with dung, and my crops continue to improve. My fences are now all made, and I have planted 4000 quick-plants in the dead places, besides elms in the hedge-rows, &c."

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*Observations.*—We wish to call the attention of landed proprietors to the above statement: how many ten thousands of acres, nay, hundreds of thousands of acres, of upland pasture, does England contain, in the same or in a still more wretched and neglected state than the land here described! most part of it, however, not containing any rock which can so readily, as in the present instance, be turned to the purpose of draining, and to fencing also, in many instances. From the complete possession which hardy *broad-leaved* weeds of every kind are known to get, in pastures thus neglected, to the exclusion of all the *grasses* but some of the very worst species, we are inclined to suspect a slight inaccuracy of our fair writer, in stating, the first crop after the draining, before any manure was applied, for encouraging the growth of the dormant and nearly smothered seeds and roots of the good grasses, to be "all of the best herbage:" in the greater number of cases this would scarcely ever come about, but by the most carefully repeated weeding, or spudding and drawing of the rank weeds. On which account, Mr. *Young*'s advice in his note hereon, is certainly judicious, in recommending the paring and burning of such lands, *in order to lay them down again with good grass-seeds*; but he ought, we think, on this occasion, to have entered his solemn warning, or protest, against taking *repeated crops of white-strawed grain* in the interval, until the land should have thereby become exhausted and again foul: an event which *very rarely* fails to happen, after the fiery ordeal, which he recommends on almost all occasions.

*On the Draining of boggy Land. By Mr.* J. Carpenter.—*Agric. Mag.* Nos. 81 *and* 82.

The first of the drainages here described, exceeding 60 acres, was effected by Mr. *Masters*, a neighbour of and follower of Mr. Elkington's method of draining, as it is generally though improperly called (see Dr. Anderson's Essays, vol. i. page 119, or the Encyclopædia Britannica, vol. iv. page 2524, 2d edit.). The land intended to be drained, falls gradually from the upper side, towards a brook on the opposite side. Mr. Masters began at the lower end next the brook, shallow at first, to secure a proper fall, continuing until he came sufficiently into the bog; then, cutting a trench 4 feet wide *from* 8 *to* 9 *feet deep*, carried it on from end to end, near three parts in four distant from the upper side, and about one fourth part distant from the brook. While this work was carried forward, the borer of Mr. Elkington's invention was employed by two, three, or four men (according to the hardness of the separate layers of earth mixed with stone or gravel, considerably below the bog), who forced the instrument 7 to 9 feet below the bottom of the drain, at about every 4 yards distance. One vent for the single drain intended, might have been sufficient, but an obstinate neighbour refused to let it pass through an intervening piece of his land; on which account, a second mouth or vent was begun, as at first. The borer always produced some water, and in many places it issued with great force. Stones cut from an adjacent quarry, about 18 inches long and 8 in depth, were placed on each side of the drain, 6 inches apart; then a thin turf was put on each, outside of the stones, to keep out the loose earth; over this turf gorse or rushes were put, and then the drain was filled up with the earth which came out of it: the same being levelled and trode well, as it was filled in, to prevent surface water making its way down into the drain, and carrying the loose earth down with it. As soon as the draining was effected, the surface was pared and burnt, and potatoes were planted, which proved an abundant crop; then, after two strong and good crops of oats, it was laid down with grass-seeds, after a clean fallow.

The second drainage described by Mr. *C.* was on upwards of 90 acres, worth on the average not 15*s.* per acre, producing an indifferent kind of rushy hay, difficult to carry off without miring the horses employed. This meadow was, many years ago, drained in an imperfect method; cross trenches were made, shallow and numerous, which often wanted repairing, being bottomed with loose stones or wood, and only carried off a part

of the spring-water. This meadow is situated between two hills, and the water occasioning the bog issues from both of the hills: a drain constructed as described in the last case, was carried up on each side of the open drain, or brook, through the meadow; this made the land sound, the rushes disappeared, and the hay is now of good quality; the land cheap at 40*s*. per acre, though but partially watered, in rainy times, owing to the obstructions of a neighbouring mill, or it would be worth 60*s*. per acre.

"There are many (says Mr. *C.*) possessed with an erroneous opinion, with respect to making the drain in its proper place, and perform the work at the *upper* instead of the *lower* part, which they call breaking the springs in the first instance; but when this is done, they find the mistake, and are obliged to make another near the descent:" and continues Mr. *C.*, rather exultingly, "When you want to draw out a barrel of liquor, would you choose to tap the vessel at the top or the bottom?"

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*Observations.*—Having seen considerable practice in the art of draining, in variety of soils and situations, enables us to object to such imperfect accounts of drainages as the above, and to remark, that no *plan* or map, however correct, of the *surface* of a drained meadow, can be of the least general use, towards teaching the art of draining, if unaccompanied by a correct *section* of the sub-soil or strata of the meadow, and of the adjoining hills, particularly shewing the light or porous stratum, strata, or alluvial matters, which supply the water, and (as is in most instances the case) the strong or water-tight stratum which throws the same out upon the surface. Those of our readers (and we hope they are numerous) who have read and studied the *sections* of lands in want of draining, published so long ago by Dr. *Anderson*, as above, by Mr. *Wedge*, and, more recently and fully, by Mr. *Johnson* under the patronage of the Board of Agriculture, and by others, cannot fail of observing how perfectly empirical are the above rules by Mr. *C.*; and what incalculable mischief such may do, where gentlemen, their agents, or farmers, in other situations, attempt such expensive operations as are here recommended, without a much deeper knowledge of this very intricate subject. Mr. Elkington, the boasted author with some, of modern draining, was unfurnished with the general knowledge essentially necessary for distinguishing the *particular case* of draining, which, like Mr. *C.* above, he had long and practically succeeded in, from the *very numerous other cases* which occurred in different parts of England, while the mania for employing him every where unfortunately continued: and hence his egregious failures at Prisley (see *William Smith*'s Observations on Water-meadows, p. 94), at Woburn, &c. &c.

*On Irrigation. By Mr.* Thomas Davis, *of Longleat.—Bath Papers,* vol. x.

If (says this experienced agriculturist, writing to a friend who had consulted him respecting marsh land) any of your land be capable of irrigation, and you have *water enough* to do it properly (the great error has been in attempting too much land with limited quantities of water), no improvement can be so great; but the land after under-draining, if necessary, must be by nature, or made by art, capable of draining itself, and that speedily, from the water brought on by irrigation, or the attempt should not be made. Marsh land is seldom of this shape, unless a river runs through it, and there is of course a natural fall in the land: where you have that advantage, embrace it by all means; if you have not, be shy of attempting any thing on a large scale, until you have consulted some one who perfectly understands the subject. Begin with a little, and do that little well. You must not pretend to undertake irrigation by any written instructions which I or any one else can give you: you must get a man *who understands the subject practically,* and who will undertake the work at a fixed price per acre: but even then, I would do but little at first, then wait a year, and see the effect, before I would go further. And it is absolutely essential that your own workmen should see the effect, and understand the subject, and be fond of it; for every farmer, let him profess what he will, is governed by his own workmen; and whatever he may attempt, will never fully succeed, unless he can get them to like it, as well as himself.

*Observations.*—Such are the judicious remarks of Mr. *D.* than whom few are better acquainted with rural affairs in general. By *men who practically understand the subject,* especially if called to act or advise beyond the sphere of their own local practice, we have the means of knowing that Mr. *D.* means, men who make or profess no *secret* in this art, but who can and are ready, on all occasions, to give a plain and satisfactory reason for every minute particular in their practice: the good effects of judicious, well-timed, and courteous explanations from such a man, to the workmen and superintendants on a gentleman's estate, cannot fail of being apparent in removing the prejudices, so truly represented by Mr. *D.* as fatal to all attempts at introducing new practices into a district.

*On Plantations of Wood for Fuel, &c. By Mr. J.* CARPENTER.—*Agric. Mag.* No. 81.

CONSIDERING aquatic woods as the quickest growers, and such as may be planted till the middle of May, Mr. C. proceeds to mention—

1st. The hop sallow, which, when planted near rivers or brooks, should be of a length not to be injured by cattle: it is a quick grower, and the heads bear wood for bundles, in five or six years: the refuse used for fuel.

2d. The common withy is, on many accounts, to be preferred to others, and grows with the least moisture. A small enclosure of these, planted about twelve years ago, in holes made by an iron bar, with cuttings about a foot in length, have since proved very serviceable, in having annually a supply for hedge-binders and kidbands: the refuse, and what is not wanted for other uses, do well for the fire.

3d. The alder. This requires more moisture for its growth than the two former; it may be set as late as the end of May or beginning of June: seedling plants may be purchased at about 6*s.* per thousand, and planted like white-thorn. This wood, when alternately wet and dry, rots very soon; but if always under water, it will harden like a stone: it is good for the turners, and several mechanic uses, and turns out a deal of fuel.

There are many dry districts, where birch, broom, and furze may be planted or sown, in spots of land very indifferent, and worth but little for any other purpose: the last is particularly adapted to the heating of ovens.

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*Observations.*—Quick as the growths of aquatic woods are, few Landlords of discernment would wish to see them cultivated on their estates, but in one of the three following situations:—1st, on wet banks, or in gullies, too steep for cultivation; 2d, in tracts of marsh or boggy land, which, owing to the intervention of a mill-dam, a canal, or an unaccommodating neighbour's land, cannot be drained; or, 3dly, by the sides of watery dikes, running waters, or ponds, or on low or small islands in such. The deleterious effluvia from bogs, marshes, alder cars, and ozier beds, have a visible effect on the health and longevity of the inhabitants, wherever they unfortunately abound; on which account, as well as the superior profit of such lands when drained or irrigated, their improvement in these last ways is to be recommended.

*On the Mildew in Wheat. By Messrs.* J. MEDLEY, T. MILLER, *and* J. HOWLAND.—*Young's Annals,* No. 259.

MR. Medley says, that the oldest persons living in the neighbourhood of Leeds, in Yorkshire, never remember the wheat so mildewed as in the year 1804; he inclines to think the succession of wet, damp weather in June, July, and the beginning of August, in that year, to have been the cause: different soils appeared equally affected, unless, as some say, limestone bottoms suffered rather the most; late-sown and late crops were the worst: low and sheltered vales were much affected; thin crops fared the best, and the best crops, whether from manuring or otherwise, were the most affected. Red wheats are thought to have suffered rather the least: early cutting appears the only course to pursue.

Mr. Miller thinks the strongest soils near Wolverhampton to have been most affected; lands hanging to the north or north-east suffered most, except low sheltered places. Thick-sown crops, if standing up and clean, least affected: the worm or grub-bitten plants the worst; limed crops were the best; the scent of the Barbary flowers is thought to affect the wheat crops in the direction of the wind: red and bearded wheats the best. Early cutting is prescribed; for if the straw stands long, it becomes rotten, and will not hold binding.

Mr. Howland thinks the light gravelly soil, near Ellesmere, suffered the most from the fogs and frosts which were there so general: early cutting is recommended.

*Observations.*—These inquiries, instituted by the Secretary of the Board of Agriculture, are very praiseworthy, and so soon as all the answers have been received and printed, we hope that he will oblige the agricultural world with a synoptic view of the results of these interesting facts and opinions.

*Means for curing the Foot-rot in Sheep. By Mr.* J. CARPENTER.—*Agric. Mag.* No. 81.

WHEN the disorder is discovered in one or more of the flock, the sheep should be immediately housed, to prevent the complaint from spreading further: then, with a sharp knife, cut away all the rotten parts of the hoof, and apply to the place, with a stick, a slight covering of the butter of antimony *(sublimed muriate of antimony)*: the sheep should not be turned to

pasture before the next morning, as the wet or dew may injure the effects of this dressing; sometimes the upper part of the hoof is affected; this must be cut away and dressed, as above, to effect a cure.

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*Observations.*—Mr. C. states, that this disorder, though common among his long-wooled sheep, has not been heard of by him, among the fine-fleeced Ryeland breed: we have known the South-down flocks, on sandy districts in the midland counties, distressingly affected by it. Mercurial ointments are there used with success, after paring carefully the diseased hoof: shepherds cannot be too attentive to the first appearance of this dreadful malady.

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*On Smearing of Sheep. By* A. S.—*Farmer's Mag.* No. 26.

From the earliest period, it seems to have been customary to smear or salve the backs of sheep in the autumn; in Scotland an ointment of tar and butter is generally used, costing sixpence or more for each sheep.

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*Observations.*—The many and opposite uses and virtues of smearing, confidently ascribed to it by its different advocates, occasion this correspondent, and we think justly, to doubt whether it is of any real utility, while it has some obvious inconveniences.

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*On Milch Cows. By* C. H.—*Farmer's Mag.* No. 26.

It has been a remark often made, that the quick-feeding breeds of cows are bad milkers; but this correspondent states the very reverse to be the case; and that the cow which gave the greatest quantity of butter in a given time, fed the fastest when dry; also that ewes which produce the fattest lambs, are the first to become fat themselves. In buying barren cows to feed, such as are aged, if they have teeth to eat their meat, are preferred to younger ones, which are parted with for not giving enough of butter. The small bone, the fine shape, the thin skin, the mellow *undescribable feel*, so much talked of by the connoisseurs in breeding, are the very marks of a good milker. Sometimes very ugly-shaped animals, possessing the other properties, prove great milkers: their fault is, that they do not afterwards lay the fat on the most valuable parts, a quality which seems inseparably connected with fine shape, or beauty of form, as the breeders term

it. Great milkers are such as yield the greatest quantity of butter in a given time: a great quantity of thin milk is out of the question, even where the same is sold, as the sellers are at no loss to add water to rich milk, till they bring it to the standard quality of the market.

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*A Receipt for making Butter in Winter. By* G. D.—*Farmer's Mag.* No. 26.

PREPARE in summer, about half the quantity of butter used in winter for the table; salt it, and dye it pretty deep with marygold or *anatto*. In winter, put as much of this butter into the churn, as shall be equal to the quantity you expect from your winter cream: churn them together. The produce has the look and flavour of summer butter, and is not salter than most people like new butter to be.

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*On the Management of live Stock on arable Farms. By Mr.* CHARLES HOWARD.—*Farmer's Mag.* No. 26.

THERE are comparatively few arable farms that would not maintain and fatten a double quantity of stock, and perhaps in some three, four, or five times the present number, without lessening the annual produce of grain: the advantages resulting from such an increase of stock are too manifest to be overlooked, and call loudly for attention. By a proper combination of green crops, such as tares, clover, and buck-wheat, for summer, turnips, carrots, potatoes, cabbages, and kale for winter, it is certainly possible for the tillage farmer, to support and fatten a quantity of stock equal to the grazier, on the same number of acres, the soil being of a similar quality. To do this, a considerable capital will be necessary, as the whole expense of an arable farm is added to that of a grazing one: in the purchase of stock for breeding it will be invariably found that the best are the most profitable, and that attention to breed cannot be too strenuously recommended in animals of every species; size is no proof of excellence in any stock; the great object of the farmer should be to gain the greatest possible weight of animal food, from a given quantity of vegetable. The arable farmer should have such a supply of green food as will enable him to keep all his horses, cattle, and pigs in the farm-yard throughout the year; except very young stock, which do not appear to answer quite so well in confinement. One acre of red clover, mown and carted to the farm-yard, will, it is confidently affirmed,

afford more sustenance during the summer, than three acres of the best old grass-land pastured. Stall-feeding is considered as preferable to giving cattle, food in racks in the farm-yard: they are at all times quiet, and less disturbed by flies in summer; while the shelter in winter is highly serviceable: dry littering is also essential. The expense of soiling is doubtless great; but the additional stock supported, together with the immense return of manure, and consequent amelioration of the land, far outweigh it. One man will cut, cart the food, and attend to a very considerable number of cattle, the land being good and lying near the farmstead; and one or more men should always be appropriated to this business only, as nothing contributes more to the thriving of animals than regular attendance: the food ought to be given frequently, in small quantities, and never allowed to stand before them; their troughs ought to be kept sweet and clean. Variety of food too, is necessary, rendering it also easier to provide for every season, and allow the land frequent changes of crop. The number of acres sown with corn will hereby be diminished; yet, from the increased excellence of the land by the green fallows, such abundant crops would be insured, as to make the produce of grain fully equal, if not to exceed, all that could be raised by more frequent introduction of corn crops.

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*Observations.*—These remarks are given by Mr. *H.* as the result of his own practice, and are such as will doubtless stand the test of experience (see our first vol. page 292). Much has been said, and that rather clamorously, by some, about *cultivating our wastes*, nearly all of which are either at present productive in pasturage or fuel; or are naturally too sterile to yield an adequate return, for the expense of cultivation: *low* lands in want of draining, will certainly answer well to their improvers. Let us endeavour to invite sufficient capital to agricultural pursuits, for accomplishing more generally the objects pointed out above: how many thousands of acres of the present pastures might then be dispensed with! and the same be cultivated for corn, instead of sending our millions out of the kingdom to enrich the farmers of other countries. It is in vain to talk of lessening our present consumption of animal food, in any material degree; but we have here the means suggested, of producing it from a far less surface of land, and of course more corn might be grown. From a more general adoption of draining and irrigation, we have also very great things to hope.

*On the Improvement of poor Soils, where Lime and Manure cannot be had. By Dr.* J. ALDERSON.—*Young's Ann.* No. 259.

THE Holderness Agricultural Society meet at Hedon, in Yorkshire; they propose at each meeting a question on agricultural or rural affairs, which is to be discussed by the members present at the ensuing meeting: the essay before us was produced and read in one of these highly useful discussions; and we regret sincerely, that our limits will admit of giving no more than a slight sketch of its contents. Soil, according to Dr. A. consists of certain proportions of the simple earths, of which there are six or seven, but as three of these compose by far the greatest portion of soils, it will be sufficient for general purposes to note, that these three are, *chalk, clay,* and *flint,* or *sand.* According to the best information on the subject, if taken generally, soil, when divided into eight parts, ought to consist of three parts of clay, three of chalk, and two of sand: the last article admitting of great variations with respect to its fineness or coarseness, according to the climate, or quantity of rain which falls. A soil consisting entirely of clay would not part with its water sufficiently to fit it for the purposes of vegetation: chalk would part with it too fast; and flint would not retain it at all. There are many plants we wish to cultivate, whose tender fibres are not able to penetrate clay; others that will not be sufficiently at rest from the loose and changeable nature of sand; and others that cannot act upon chalk. A due mixture of the earths is necessary to form a fertile soil, and barrenness depends on a deviation from the proper proportions. Before the improvement of a poor soil is attempted, we should ascertain what the nature of it is: in which earth it is deficient, and what in it superabounds. If it be too clayey it may have a proportion of chalk and sand added: and where such cannot be had, stiff clay soils may, in some situations, be rendered more open, by burning portions of them in heaps, and then ploughing the hardened earth into the land (see page 132 of our last number). Sandy soils, even such as are liable to blow away, as in Suffolk, Norfolk, &c. may be stiffened by clay; but marl (commonly containing sixty-six to eighty parts of chalk in its composition) is far better, where it can be had.

In order to account for the circumstance, why a mixture of the earths should be essential to the purposes of agriculture, Dr. A. wishes to carry the analogy between "the changes which take place by the action of fire in combustion, and those changes which constitute or exhibit animal and vegetable life," so far, as to argue the probability, that the different component parts of the soil, when pulverized and mixed by cultivation, are capable of

acting on each other, and forming the various compounds which we find in vegetable productions. The fact, that pure clay, chalk, or flint, placed in a crucible, will not melt, or suffer any material change in the hottest furnace, while, if these be mixed in certain proportions, a proper degree of heat will liquefy the mass, and the compound, when thus intimately combined, will form a substance with properties distinct from any of the simple earths, is brought forward to illustrate the operations of ploughing, harrowing, hoeing, and rolling, so necessary in husbandry; whenever plants have drawn from the soil, in the spot where they grow, all the materials that happen to be duly mixed, they are no longer capable of thriving, until, by a new operation, more particles are brought into contact: horse-hoeing, and the repeated ploughings performed as a preparation of the ground for the reception of fresh seed, are also mentioned as an illustration of the same theory; whence also, we see the reason why marl becomes so admirable an addition to some soils, as to be called a manure, the clay, sand, and chalk, being therein so intimately combined, that it is capable of being acted upon by plants; the action of whose *living principle* seems analogous to the power of fire in altering the arrangement of the particles of matter, elevating some into the form of gas, and rejecting others: the use of this principle perhaps being, to bring together such particles of matter as, when duly acted upon and assimilated, will constitute the essence of each species or variety: from the same nourishment, different living powers producing totally distinct matters, only by new arrangements. The fibrous roots of plants effect the first stage in the transmutation of inert matter into life, whereby earth becomes vegetable matter, which is no sooner decomposed in the stomachs of animals, than it is capable of being converted into animal matter: the same, "when farther eliminated and purified by the delicate organs of the human species, reaches the utmost perfection of created intelligence." Oil, says Dr. A. which some have denominated the food of plants, can no more enter the fine vessels of plants, than any one of the simple earths; it must first be decomposed: milk also does not enter the lacteal veins of animals (although it so nearly resembles blood); it must undergo decomposition, and be digested, as well as any other food, before it can serve the purposes of nourishment. There are many things to be done, and many to be removed, before barren soils can be made productive: particular plants or weeds may sometimes be raised thereon for profit or manure, however poor the land, as sainfoin and fumitory on chalk, thistles on clay, prickly spinach, sow-thistles, buck-wheat, and other succulent plants, which, when ploughed in, will afford a very considerable supply of food for more useful plants, or their ashes might be made stimuli to the growth of such. The advantage of shelter by plantations of forest trees in exposed situations, is next insisted on by

Dr. A. who states an abundance of the calx or rust of iron to be a source of barrenness; these ferruginous lands are either of a red or a blue colour: the iron in this case is thought by Dr. A. to be produced by vegetation, and that the willows, alders, rushes, mosses, &c. produce more iron than other kinds of plants, in the soil in which they grow. The draining of wet lands, and constructing catch-water drains, and reservoirs, to hold up the water in dry situations, is suggested, by which the low lands would escape flooding during violent rains, after which the dry uplands might be greatly benefited by irrigation. Of this practice China is cited as an instance, where a small rivulet well managed, sometimes produces fertility in a whole province. Proper situations are pointed out by Dr. A. where, in Holderness, the springs and streams might at the time of the enclosure of certain parishes have been diverted and applied to the purpose of irrigation. The soaking of gypsum or plaster of Paris in sea water, where these two are to be had, is recommended by Dr. A. as the means of making a valuable manure when mixed in a compost. Farm-yards are here recommended to be strewed with sand in some situations, as in Norfolk, for imbibing the urine of the cattle. In the same manner that some plants impart or give out iron to the soil, as above-mentioned, Dr. A. supposes that every sort of grain, not only imbibes certain things from the soil, but gives out a something else which acts injuriously on a future crop of that particular grain, especially if immediately repeated; and hence he would infer the necessity of a rotation or successive change of crops. The practice of preserving stubble lands whole or unploughed after harvest, to be exhausted by the growth of weeds, is much censured.

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*Observations.*—The very full analysis which we have given above of this long and curious paper, leaves the less for us to remark here. It is much to be doubted whether Dr. A.'s ingenious theory to account for the amelioration of soils and the production of vegetables, will stand the test of experiment, better than the many others which have preceded it; but the observations respecting the uses that may be made of succulent plants or weeds on poor lands for enriching them, are well deserving of notice. The idea has for some time been entertained of iron being generated or collected in the soil by some vegetables; and that such ferruginous matters do, in some instances, prove the cause of sterility, is, we think, confirmed, in the instance of the sandy Heaths, in Bedfordshire, and other places, producing few other plants, besides heath *(erica vulgaris)*, which in a surprising manner blackens the sand, in which its roots strike, and renders it ten times more steril and unfit for vegetation than the red sand beneath it is: we remember Mr. Pontey (the writer on planting, pruning, &c.) pointing this out several years ago, as particularly

apparent with the larch plants on a heath of this kind, that had been planted some years before; all of the trees that were planted in old stone-pits, or in holes deep enough for their roots to feed entirely in the red sand, were highly vigorous and thriving; while almost every one planted in the black sand on the surface was either dead, or in a dying state. The particular state of the iron in this blackish sand, is a very probable cause of its barrenness; but the red oxides of iron are certainly rather friendly than otherwise to vegetation in some instances, witness the red and rich lands, which accompany the coal-measures through many counties in England, and the effects of ferruginous water on meadows upon peat of the same nature at Prisley (see our 1st vol. p. 288) and in several other places.

Our readers will find many valuable hints on the subject of Reservoirs for preserving flood waters for irrigation and other useful purposes, by Mr. Jessop, the engineer, on inspecting the Repertory of Arts, &c. vol. iii. page 243, of the First Series; and by a reference to the article *canal,* in Dr. Rees's Cyclopædia; they will find, that the suggestions above, respecting setting out irrigation-works, at the time of an enclosure, were several years ago carried into effect in different parishes, where the late Duke of Bedford had property under enclosure.

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*On the Improvement of Moss Land. By Mr.* J. Mac Neil.—*Farmer's Mag.* No. 25.

The land consisted of mossy soil of various thickness on a substratum of the finest shelly sand, the general surface being nearly a perfect level; after drains had been cut in various directions to such depth as effectually to carry off the surface water, it was ploughed in the autumn where practicable, and the soft and uneven parts were leveled with the spade; 12½ tons per acre of shelly sand were spread over it, and it was afterwards covered with black-wreck, a sea-weed; the sea-weed was covered with soil from the furrows, and potatoes were dibbled in at the rate of 1½ ton per acre, and a crop of 20 tons per acre was afterwards dug: the succeeding crop was oats. Another piece of moss reclaimed by Mr. M'N. was in a worse state than the former, the water having stood so much upon it, as to produce an entire crop of reeds; the whole of the first breaking up and leveling was obliged to be done by the spade, and the manure to be carried to the spot in hand-barrows.

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*On the Mildew or Blight in Corn, and Steeps for Smut. By Signor* Balsamo *and Mr.* Mackie.—*Young's Ann.* No. 258.

Mr. Arthur Young has given the results of several inquiries, made very generally through the island of Sicily, by *Signor*

*Balsamo,* in 1804, for ascertaining the cause of the fatal mildew then experienced. Among the probable causes assigned, are the very long drought after sowing, and the great glut of wet which followed in the spring; it was not apparently caused by any extraordinary fogs or dews, but was general with all grain throughout the island: the dunged crops seemed most injured; gravelly and light soils were least affected.

Mr. *William Mackie,* of East Lothian, states his practice to accord with the opinion given by Sir *Joseph Banks,* but so violently opposed by some writers, in favour of sowing in some cases thin or blighted wheat, instead of the plumpest and best corn which can be procured, as generally recommended and practised. Mr. M. states, that in 1779, a large sowing of spring wheat was made in East Lothian, all of which was blighted or destroyed by the rust or mildew, although the autumn-sown wheats as uniformly escaped the contagion: in this year some picked spring wheat, of the plumpest and finest grains, produced a crop "so remarkably light and meagre, that with great difficulty it could be separated from the chaff, and *not a grain of it would sink in pure water:*" in the same autumn this shrivelled corn, brined and limed as usual, was sown in a fallowed field, the remainder of which was sown with the best seed wheat, which could at the time be procured in Haddington market. During the spring and summer, no difference between the produce of the two seeds could be discovered, and *the whole field escaped the mildew,* but at harvest a few ears of smut appeared, among the produce of the plump seed, while not a single smutty ear could be found among that from the meagre, mildewed wheat; and when thrashed, the latter was found the best in quality by two pounds in the bushel, and the produce per acre at the same time eight bushels per acre, more than from the good and costly seed. Mr. M. attributes this superiority to the former kind being a more productive variety of wheat, which even its highly mildewed state could not counteract. Several other East Lothian farmers sowed of this blighted spring wheat in 1780, with similar success to the above, and Mr. M. relates the case of a farmer, in a high and exposed situation, where wheat can but with difficulty be grown, who has long and successfully sown his light wheat or out-dightings, collected in dressing his wheat for market. Mr. M. however, recommends caution to farmers, in trying this experiment, and not to use grain which is rendered light, so as to be blown off by the fanners among the offal or out-dightings, by being attacked with *smut:* the sowing of mildewed wheat in the autumn, Mr. M. confidently recommends from his own experience.

# REVIEW OF SPECIFICATIONS OF PATENTS,

PUBLISHED IN THE REPERTORY OF ARTS, &c. IN THE MONTHS OF APRIL, MAY, AND JUNE, 1806.

*Mr.* JAMES BOAZ's *Patent for a new and improved Method of raising Water, and working Machinery by means of Steam. Dated July* 1805.—*Repert. Arts,* No. 47, *New Series.*

MR. Boaz's engine he distinguishes by the name *pump*, and it admits of great variety in its construction, while it preserves the same distinctive character. The body of the pump in one of Mr. Boaz's methods of construction is divided into two nearly equal compartments, by a horizontal partition, into the middle of which is fixed a vertical tube open at both ends, and rather to one side a valve opening into the upper compartment: the steam passes from the boiler into this pump, by a bent tube, which enters the pump just below the horizontal partition. The piston which fits the interior of this pump is a floating one, of such specific gravity as to rise and fall with the surface of the water in the lower compartment of the pump: the piston has a perforation throughout its middle, to admit of its rising and falling in the body of the pump, without being obstructed by the vertical tube; and to the bottom of this piston is fixed a long rod, which works through the tube, and a stuffing box at the upper end; so that its upper end may work the hand gear (placed at the top of the pump) by means of the motion of the piston. The hot water cistern is placed immediately above the pump, and has a breathing valve opening into it, as well as a returning cock: the hot water tube proceeds first horizontally for a small distance, and then turns downward, by an elbow, into the vertical direction towards the well. At a suitable distance below the pump it is so bent as to form a kind of fork with the cold water tube rising from the well, the latter being carried up vertically to the top of the pump, where is the cold water cistern, the delivering valve from the pipe opening upwards into this cistern. The returning cock from the hot water cistern is regulated by a float.

In the operation of this steam pump, the necessary preparation is to fill the whole with the hot and cold water tubes, and their respective cisterns, with water. The steam is then admitted

through the valve of the steam-pipe into the lower compartment of the pump, by which means the water becomes heated: when it has approached the boiling point, the upper surface of that in the lower compartment being pressed by the steam, and the water not being permitted to escape elsewhere, is forced up the central tube into the upper compartment of the pump, which being previously full of water, a part of it passes down the hot water tube; and the valve at the bottom of the tubes next the well being shut by the pressure, the water is made to ascend along the cold-water tube, and opening the valve at its top, enters the cistern, whence it finally escapes through a spout. When the steam has displaced about half the water in the lower compartment of the pump, the piston, which always descends with the surface of the water, acts by its rod upon the hand-gear, which shuts the valve in the steam-pipe, and opens the eduction valve in the horizontal partition; the consequence of which is, that the water in the upper compartment descends by its own gravity through the central tube, and forces the steam in the lower compartment to pass through the eduction valve into the upper compartment; in which, ascending by its relative levity, it comes into contact with part of the bottom of the cold-water cistern, and is condensed: a vacuum being thus formed, the atmosphere, to restore the equilibrium, forces cold water from the well, up through a certain portion of the hot-water tube. While this is going on, the piston will have risen to the top of the lower compartment, when its rod will cause the hand-gear to shut the eduction valve, and open the steam valve; through the latter of which fresh steam will pass from the boiler to the pump for another stroke, as before. Should any air have been injected along with the steam of the last stroke, or otherwise, it will have ascended to the top of the pump, and be there lodged. In order to get quit of this air, which, if allowed to remain, would affect the vacuum of the succeeding stroke, the very small breathing valve is placed on the top of the pump, opening into the hot-water cistern, where it is always covered with water; so that whenever fresh steam presses into the pump, the pressure opens the breathing-valve, and allows the air to escape, a small quantity of hot water always escaping with it. This hot water would accumulate, and in time run over the cistern, were it not that a cock at the bottom of the cistern is opened by its float whenever the hot water attains a certain height, and the superabundance thus delivered back into the pump. By this manner of operating, no cold water from the well is ever allowed to enter the body of the pump; for all that ascends into the hot-water tube at each stroke is met by the hot water, whence it is forced to descend, then to ascend through the cold-water tube, and ultimately to escape by the spout from the cold-water cistern. The vacuum

produced is very perfect, the pump being completely purged of air, through the breathing valve, every stroke.

When it is required to force water above the pump, after it has been raised in the preceding manner by the atmosphere, the spout proceeding from the cold-water cistern is closed up, and an additional vertical tube is attached to this cistern. The pump then works as before, only it will then require stronger steam. In both cases, the boiler should be fed out of the hot-water cistern.

The same general principle of construction receives slight modifications, according as the water is to be raised through smaller and larger elevations. When it is proposed to raise water several hundred feet, Mr. Boaz directs that it be raised by stages of about 20 feet, by a series of vessels and pipes in the pit, similar to a method invented by Mr. Peter Keir, and long ago published by him. Mr. Boaz's adaptation of this method need not be described here.

When it is required to raise the water which is to feed the boiler through a considerable distance, and to work with steam of a high degree of expansibility, Mr. B. has two cylindrical vessels, both of which have a pipe entering their bottoms from the well; one of them has two horizontal tubes communicating with the bottom and middle of the boiler, and the other a horizontal tube communicating with the top of the boiler; the former vessel may be called vessel B, the latter vessel E, by way of distinction. The vessel B has a float, and its float-rod works a tumbling-bob, consisting of two levers, and by that mean opens and shuts, a cock in the tube passing from vessel E to the top of the boiler. When the water in the boiler gets low, the float in B falls, and the uppermost pin on the float-rod presses upon that arm of the tumbler on which there is no weight, bringing it down till the weight fixed on the other arm of the tumbler passes the vertical position, falls down on the other side towards the boiler, and striking against one of the pins in a round plate, which forms the head of the cock, opens it by a sudden jerk. The steam then rushes from the boiler into vessel E, which is previously full of water, and pressing upon its surface, forces it all through a forked tube below into the other vessel B, which stands nearer the boiler. This sudden accession of water in B raises the float, and causes the lowermost pin on the float-rod to raise up the tumbler, and thus to shut the cock: hence the steam in E is insulated, and soon becomes condensed; so that the feed-water rushes up the pipe, and again fills the vessel E ready for delivery into the boiler whenever the fall of the float solicits another supply.

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*Observations.*—Mr. Boaz remarks that the alternate motion of the water in any of his methods may be made to work machinery

by means of a piston, or otherwise, instead of raising other water; or that the raised water may be made to operate as a first mover: we apprehend, however, that this application of his inventions will not be found of much utility. We conceive that the chief advantages this steam pump will furnish, will be when it is used in the simple state of our first description; for in that case, as the fluids in the hot and cold water columns nearly balance each other, there will not be much more power required than that which will overcome the friction against the sides and sinuosities of the tubes; of consequence, steam which is comparatively weak may work the engine in this state. We cannot say that the appropriation of Mr. Keir's invention to that of the present patentee, seems to us likely to be productive of any such beneficial consequences as would be commensurate to the expense of the erection of so complicated a piece of machinery.

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*Mr.* William Scot's *Patent for Improvements in the Manufacturing and Working of various Kinds of Glass. Dated August* 1805.—*Repert. Arts*, No. 47, *New Series.*

The object of this patent is to secure the right to manufacture plate glass from the circular planes prepared for window glass, which are first blown into large globes, and afterwards expanded before a powerful fire, by the centrifugal force given to them in whirling them round their centres, when sufficiently softened by the heat.

The advantage of the invention is, that small plates may be made in this way of much thinner glass, and consequently cheaper, than by the usual method of casting the plate on a metallic table, and over the soft glass passing a roller, guided at a regulated distance from the table.

The process which Mr. Scott directs is to cut the glass, prepared as for window glass, into squares or panes after it is drawn from the annealing kiln; and to place two, three, or more of those panes on each other in spreading or annealing kilns, upon flat surfaces of stone, glass, or other substances, in such a degree of heat as shall cause the glass squares to yield to the surface on which they are placed, and thereby become flat and adapted for grinding and polishing: which operations are directed to be performed in the usual manner.

*Mr.* Samuel Anness's *Patent for Methods of preparing various Enamel Colours, and applying the same to ornamenting useful Vessels of Glass. Dated Nov.* 1805.—*Repert. Arts,* No. 47, *New Series.*

The method of enameling on glass which Mr. Anness uses consists in mixing with different colouring ingredients, a fusible compound which melts with a smaller heat than glass, so as to adhere to it, while the glass remains uninjured by the process. The fusible compound consists of acetite of lead in crystals (called by Mr. Anness, *saturnus glorificatus)* 1lb. calcined natural crystal 1lb. *polverine* or other alkali 1lb. mixed together and baked in a slow heat about twelve hours, then melted, and the mass pounded in an agate mortar, or other vessel sufficiently hard and not metallic.

Other fusible compounds are mentioned in the specification; but the one stated here is most recommended by Mr. Anness.

With this compound various metallic oxides are to be mixed for the different colours: for green, the chief ingredients are copper dust, or blue vitriol, or cobalt and Naples yellow; for black, manganese and cobalt; for yellow, antimony or Naples yellow; for blue, cobalt; for white, oxide of tin, prepared by nitric acid; for purple, oxide of gold, prepared by aqua regia; and for brown, calcined iron.

These substances fused with the fusible compound, and certain proportions of nitre, litharge, and sometimes of sand, are afterwards ground; and then either mixed with oil or gum water, by grinding, and laid on the glass with a pencil; or laid on by printing with a glue bat and copper plate; or by dipping the glass in the colour, prepared with the above fluids to the consistence of cream. The glass is then to be exposed to the proper degree of heat, to fuse the enamel and make it adhere, without softening the glass so as to alter its form.

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*Mr.* Mark Isambard Brunel's *Patent for Saws and Machinery upon an improved Construction, for sawing Timber in an easy and expeditious Manner. Dated May* 1805.—*Repert. Arts,* No. 47, *New Series.*

The saws described in Mr. Brunel's specification are circular, and turn upon an axis passing through their centre. When they are too large to be made with sufficient strength of only one piece of steel, they may be constituted of two, four, eight, &c. pieces, and the joining edge of one plate must be hollow, to receive the sharp edge of that which is to be fitted into it. To augment the

strength of the plates, flanches may be closely fitted to them, several pieces of leather or of paper being interposed, by means of which and screws duly applied, the whole may be made very firm and strong.

The improvements in the machinery for sawing timber easily and expeditiously, consist in the modes of laying and holding the piece of wood in the carriage or drag, in the facility of shifting the saw from one cut to another, and in the practicability of sawing both ways either towards or from the saw or saws.

Each circular saw is adjusted upon a cylindrical spindle, which turns within rodings; the motion being communicated by means of a strap or band turning about a proper drum-wheel, and moved by any of the usual actuating powers, as wind, water, steam, animals, &c. The piece of timber being placed upon a drag or carriage, is held fast by means of clamps; and the carriage is moved towards and from the saw by a handle or crank communicating, by the assistance of cog wheels, to a pinion which engages in a horizontal rack running under the frame of the carriage. This carriage is furnished with rollers serving to ease its longitudinal motion, and is intended to be moved by hand, so that its velocity may be varied at pleasure: the length of this carriage must obviously be proportionate to the size of the timber generally cut by the saw.

After the saw has performed one cut, instead of moving the timber, the saw itself is moved sidewise, that is, in the direction of its axle, by means of screws, after a method which may be easily conceived, till it is brought to the proper position for the next cut; when an adjusting or fixing screw prevents any lateral motion, and the rotary motion of the saw, and the rectilinear motion of the saw, may be resumed.

Circular wedges are used, being intended to revolve by the motion of the log to follow the cut opened by the saw, and by that means to ease the friction, and steady the piece of timber. Sometimes an instrument composed of several parallel plates of metal may be used instead of the circular wedges.

When several saws are adjusted on one spindle, a piece of timber may be converted into planks by being drawn once through under the saws. In that case the flanches of the saws are fixed upon an iron drum, and kept firmly in their relative parallel positions by four bolts. In order to lower the saws as they wear away, the side rails sustaining their axles may be depressed by means of wedges. The log of wood is not to lie close upon the carriage or drag, but upon some transverse pieces, which may be moved if requisite when they come near the saw.

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*Observations.*—If this patentee have not enjoyed any opportunities of seeing the principal circular and other saw-mills, now erected in different parts of this kingdom, he deserves much credit

for his ingenuity. But those who possess that advantage will find very little novelty in any of the particulars stated in this specification. When circular saws are made too large to be constituted of one plate, it follows of necessity that there must be two or more, and that these must be joined by the usual processes, with strengthening flanches, &c.: this then can scarcely be denominated an invention essentially; nor, in our opinion, can any thing in the specification, except, *perhaps*, the circular wedges, and the parallel plates sometimes used for the same purpose.

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*Mr.* Rich. Brown's *Patent for certain Improvements in the Construction of several Parts of Tables, and of various other Articles of Household Furniture, which stand upon or are supported by Legs or Feet. Dated November* 1805.—*Repert. Arts,* No. 48, *New Series.*

The principal object of this patentee is to connect the top rails or framing of dining tables, and other similar articles of furniture, in such a manner that they may be disposed or folded up into a small space when not required to be used. The several parts are connected together by joints, so disposed as to admit of the several divisions being advanced or drawn back at pleasure: the horizontal frame-work is so connected as to form a series of such figures as the mathematicians call *rhomboids*; when the motion is such as to cause the connecting angles contiguous to the advancing rails to become more acute, those rails are actually advanced; when, on the contrary, these angles become more obtuse, these rails recede, and they come close to one another, when these angles are nearly 180 degrees. A familiar idea of the contrivance may be given by referring to the common toy, on which ranks of soldiers are made to advance and recede, with a similar motion, and by a like contrivance, though more rudely constructed. When the boards of the tables are all laid in their respective places upon the expanded frame, and keyed, bolted, forked, or otherwise, sufficiently well and firmly secured in their respective situations, they constitute one piece, which gives steadiness and firmness to the whole structure.

Other improvements constituting parts of Mr. Brown's invention, relate to his method of connecting together two brackets, so that if either of them be moved outwards, inwards, forwards, or backwards, the other shall necessarily move outwards, inwards, forwards, or backwards, over equal spaces in the same time. For these contrivances, which cannot be perspicuously described without a diagram, the reader is referred to the 48th Number of the Second Series of the Repertory of Arts and Manufactures.

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*Observations.*—Mr. Brown's contrivance for causing the parts of

the horizontal frame-work to advance and recede, considered in itself, is simple, obvious, and distant from novelty; but his methods of effecting this, by means of the connecting brackets, certainly possess ingenuity, and may sometimes be adopted with advantage. The first contrivance we recollect to have seen analogous to this part of Mr. Brown's inventions, is in *Le diverse et artificiose Machine del Capitano Agustino Ramelli*, published in the year 1588: the machine alluded to is a bridge, the parts of which may be brought close together for the convenience of conveyance from one place to another; but which may, when required, by means of connecting bars, similar to Mr. Brown's, be thrown open so as to reach over a narrow river or the ditch of a fortification: the fig. is No. 146, of Ramelli's book. The circumstance of Mr. B.'s table-top being constituted of separate boards, to be arranged and keyed down, every time the table is set out, and taken to pieces when it is put up, is in our estimation a great practical objection to the use of these tables; and it will be a suitable exercise of Mr. Brown's ingenuity to devise some farther contrivance by which this objection may be removed.

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*Mr.* John Woodhouse's *Patent for Improvements relative to Canals. Dated Feb.* 1806.—*Repert. Arts*, No. 48, *New Series.*

Mr. Woodhouse mentions four subjects in his specification: 1st, A method of weighing boats when loaded or when empty. 2d, A method of transferring boats from one level to another without locks. 3d, The use of a signal or telegraph to denote the approach of boats to locks. And, 4th, A method of raising sunk boats.

The apparatus for weighing boats consists of a weighing machine, similar to those in use for waggons, supported in a lock at such an elevation that a boat can be floated under it; from this, chains descend to cross bars below the level of the boat: when the boat is over these cross bars, the chains are tightened by screws, so as to draw them close against the bottom of the boat; the water is then to be let out of the lock below the level of the boat, and the weight ascertained in the same manner on the machine by a proper counterpoise, as when weighing a waggon.

The method of conveying boats from one level to another of a canal without locks, consists in the use of coffers, into which the boats may be floated out of the levels; drums or wheels are so placed above the upper level that the coffers may be suspended by cords from them at that precise distance from each other, that one may be exactly opposite the gate or sluice communicating with the upper level, when the other is opposite that of the lower level. Each coffer is also furnished with gates. The parts round

the gates both of the coffers and of the levels are made to fit exactly to each other, and covered with leather, stuffed; so as that when the coffer is pressed against the gate of the level, the juncture may be water-tight: when in this position the gates may be opened, and a boat passed into the coffer at each level; the drums being then turned by a wheel and pinion or other means, the lower boat will be raised to the upper level, while the upper boat is at the same time let down to the lower level. The space into which it descends is to be kept free from water, and the velocity of the motion regulated by a break acting on the surface of the drum.

The telegraph, or signal, consists of a board eighteen inches long, and a foot broad, with a round hole cut through it eight inches in diameter; so supported on a post that it may be turned either edgeways or flat towards the next lock.

The method of raising a sunk boat is to moor two boats at each side of the sunk boat, one loaded and the other empty (four boats in all), the loaded boats are to be next the sunk one, and to have pieces of timber of that length and so supported above them, that one of their extremities shall be over the middle of the sunk boat, and the other over the empty boat next to it; pullies are to be placed at the extremities of the timbers, and ropes fastened to the sunk boat are to be drawn tight over these pullies, and made fast to the empty boats at each side; the loading is then to be transferred from the full to the empty boats, which will cause the sunk boat to rise.

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*Observations.*—The method of transferring the boats from one level to another without the use of locks, specified by Mr. Woodhouse, is precisely the same as that recommended for the same purpose by Dr. Anderson, and published in the General View of the Agriculture of Aberdeen, and which was copied from that work into the Repertory of Arts (see vol. ii. page 21, First Series), in 1795. But though Dr. Anderson's opinion would induce us to think well of any thing at first view, we see so many obvious difficulties in the execution, so much expense, and such liability to disarrangement in the coffers, that we think the method cannot be adopted to advantage. The bringing the ends of the coffers close against the sluices of the levels so as to be water-tight, would be extremely difficult to effect; as would also the exact fitting of the two coffers at the different levels at the same time. The weight of the coffers must be very great when rendered sufficiently strong, and the machinery for moving the whole must be very massy and expensive: cords would by no means answer for the suspension of the coffers, as Mr. Woodhouse supposes; for it is absolutely requisite that the coffers should fit at the different levels at the same time, and the use of cords would totally prevent this; for the difference of length of the cords would vary so

much at every alteration of the moisture of the air, that they would very seldom remain of the same extent for twenty-four hours.

In this plan also, if there are no locks critically speaking, there are at least used the most expensive and troublesome parts of locks; and in fact, nearly as much masonry would be necessary in one case as the other; lock-gates are equally indispensable for both; and though only one pair would be wanting for each level in this method, which would save masonry in that part, yet a great deal would be necessary in it for the support of the frames of the machinery, that would not be wanting for locks.

Supposing this plan practicable, there would be a waste of water at every transfer of the coffers, which would probably amount to more than the weight of the boats passed and their cargoes: but this would be no object of consequence, for if the loss of water could be reduced to this degree, it would be a great point gained.

With a loss of water not exceeding what is stated, it certainly is practicable to pass boats from one level to another by simple machinery, not only without locks, but without water-gates or sluices of any kind for the passage of the boats, by a method wherein no nice fitting of parts whatsoever is necessary, and which would be considerably less expensive than that here proposed. This plan we understand was contrived shortly after that of Dr. Anderson was made public; and we believe would have been long since brought forward, if the impression on the mind of the inventor, that no other way of passing boats from one level to another but by locks, would ever be permanently adopted in this country had not prevented it.

The method of raising sunk boats is liable to the objection, that it could only raise those that were sunk at a small depth; which depth must not be so much as double the draft of water of the loaded boats.

We cannot conceive that Mr. Woodhouse means to monopolize the use of signals in general on canals by his fourth invention. The instrument he recommends for this design would do as well as any other; and might also be used for other *necessary* purposes occasionally, for which its size, and the dimensions of its perforation, seem to render it very convenient. A board so perforated, is to be found ready prepared in most houses, which would make the plan more easy of adoption, and probably suggested the invention of its use in a more elevated position to Mr. Woodhouse.

*Mr.* Mark Isambard Brunel's *Patent for new Trimmings, and Borders of Muslin, Lawn, and Cambric. Dated Nov.* 1803.—*Repert. Arts,* No. 48, *New Series.*

Mr. Brunel proposes to have those narrow pieces of different fabrics, used for trimmings in borders of ladies dresses and of furniture, woven in looms of the precise breadths wanted, instead of having them cut out from the broad articles woven at present; by which he conceives there would be an advantage gained in saving the expense now laid out on such trimmings in hemming or otherwise securing their edges from ravelling, and also that they would look neater.

*Observations.*—We apprehend, that the perpetual change which fashion occasions in the exact breadth of the trimmings, &c. mentioned, would make it hazardous to prepare any stock of such matters of any determined breadths; and that there would be more lost from their frequently becoming unsaleable on this account, than could be gained by any saving of needlework in the method proposed.

*Mr.* W. Henry Lassalle's *Patent for Improvements in Soap. Dated April* 1806.—*Repert. Arts,* No. 41, *New Series.*

Mr. Lassalle directs any quantity of such *aluminous* earth as can be had of considerable purity, to be purified if needful by chemical or mechanical means, which he does not specify, then ground fine, and mixed with alkaline ley, in such quantity as to render the whole imperfectly fluid: the mixture is then to be boiled, "*with constant stirring,*" till the whole has attained a smooth uniform appearance. In another boiler a quantity of soap is prepared hot, fluid, and nearly in the finished state, amounting to three times the weight of the *aluminous* earth used. The mixture of earth and ley is to be poured hot into the fluid soap, and the whole well mixed, and boiled to a proper consistence, and then poured into the moulds. Mr. Lassalle states, that various proportions in the mixtures should be used according as it is required to make a soap more or less saline, or more or less hard.

*Observations.*—This method of making soap we conceive to be precisely the same as that for which Baron Van Doornik obtained his patent in Dec. 1804, which is noticed in our first volume, page 226; at least if there is any difference, we are unable to discover it.

There may be some doubt about the meaning of the expression *aluminous* earth; which if intended to denote *alumine*, or the earth which is the basis of alum, is incorrect. We conceive, the expression aluminous earth, more properly means the earth or ore from which alum is prepared; but as this contains a quantity of sulphuric acid, that would decompose any soap to which it was added, we must conclude, that it is nothing but alumine, or the purer varieties of clay, that Mr Lassalle meant. As the observations relative to the composition made in our First Volume, p. 226, on Baron Van Doornik's soap, will altogether apply to Mr. Lassalle's patent, we beg leave to refer to them.

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*Mr.* John Jones's *Patent for Improvements in the Mode of manufacturing Fire-arms. Dated Feb.* 1806.—*Repert. of Arts,* No. 48, *New Series.*

Mr. Jones observes that the barrels commonly called twisted barrels are usually formed by winding a small square or flatted bar spirally round a mandril, while the said bar is in a red-hot state, and then welding the junctures at successive heats, by hammering them together in the direction of the length of the mandril. The improvements, mentioned in Mr. Jones's specification, consist of a more convenient form of the flat bar, and of machinery for rolling it round the mandril.

The flat bar is directed to be formed with bevel edges, so that when those edges come in contact, one of them shall lap over the other; the bar is also to be drawn out gradually thinner from one end to the other. It is made to assume this form by passing it through rollers grooved at the surface in the shape required, and by drawing it more frequently through the rollers at its thin parts than at the thicker.

The machinery consists of a screw the length of the barrel at least, the spirals of whose thread are distant from each other a space equal to the breadth of the flat bar between its bevels: this screw passes through a fixed nut, and the mandril being attached to it, at each turn, from this formation, causes the bar to lap round it so that the bevels fall one over the other; the bar is kept hot during the operation in an air-furnace till drawn out, and passes between a pair of small rollers, pressed down at pleasure by a lever, in order that it may be rolled tight on the mandril.

The screw is turned round by a pinion working on a wheel attached to the screw, which wheel, in the drawing, is nearly four times the diameter of the pinion. On the top of the axes of the rollers vertical screws are placed to force them down; and those screws are made to turn together, by the common contrivance of a wheel attached to the top of each, worked by a pinion in the middle between them that communicates with both. The

bar is fastened to a mandril previous to the operation, by a catch, or fork, screwed to the extremity of the latter.

Any metals which are strong enough, and proper for the purpose, are directed to be used for the formation of the barrels. After the operation described, the spiral skeleton is to be welded on the mandril, and the barrel completed in the usual manner.

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*Observations.*—The machinery for the operation described, seems extremely well adapted for it; is void of all useless parts, and from its consequent simplicity is of masterly contrivance. The lapping of the bevels, or of one part of the flat bar over the other, seems so entirely necessary for the strength of the barrel, that it is surprising it has not been practised from earlier times.

A claim to the invention has been made by Messrs. Thomas and John Gill, of St. James's Street, London, in a letter inserted in the 49th Number of the New Series of Repertory of Arts, &c. which states, "that their father invented machinery for making twisted barrels exactly similar to that specified, but applied in a much superior manner, upwards of ten years ago; and that they have a gun-barrel, twisted by it in the unwelded state, and other specimens ready to shew, to substantiate their claim."

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*Mr.* John Delafons's *Patent for a Machine called by him a marine Alarum Chronometer. Dated Nov.* 1805.—*Repert. Arts,* No. 49, *New Series.*

This machine is a small piece of clockwork set in motion by a spring, that, by a motion similar to that in common clocks, strikes a bell after a certain number of revolutions of its wheels; in that of which a drawing accompanies the specification, the time is regulated by a balance-wheel worked by pullies, without any spiral spring, but with two thin pieces projecting perpendicularly from its surface to act on the air, that its velocity may thus be diminished. This movement is not meant to determine the nature of the machine; for Mr. Delafons says, that "any other escapement or pendulum spring may be applied to it;" and that in some cases a fly, moved like that of a roasting jack, may be used; three or four different methods are mentioned for disengaging the hammer that is to strike the bell, none of which are different from what has been used in other clocks for the same purpose. The movements are not described by which this machine is adjusted to strike the bell at a particular time, so as to serve as an alarum to awaken people at any given time, for which purpose it is also intended; but we suppose they are similar to those already in use for the same design. The principal use

Mr. Delafons intends this machine for, is to serve instead of the half, quarter, and minute glasses used at sea, for ascertaining the time in which a ship's log line runs out; and also for regulating the time for boiling eggs, and other eatables; but for these latter purposes a greater number of wheels must be added to the train. He makes some to go twelve hours, and others less according to the use for which they are wanted; and also makes them to go by weights, as well as by springs.

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*Observation.*—We are at a loss to conceive for what object Mr. Delafons claims an exclusive right from his patent; surely he cannot imagine that others may not make clocks to strike minutes or seconds, or to serve as alarums as well as he in future, when the same has been done so many years before; or that he can monopolize the use of movements that are severally and collectively to be found in the various wooden clocks imported from Holland for this last century.

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*Mr.* John Baptist Denize's *Patent for a Mode of procuring a greater Quantity of resinous, bituminous, and oily Substances from various Articles. Dated March* 1805.—*Repert. Arts,* No. 49, *New Series.*

In the introduction to the specification of this patent, Mr. Denize states, that the theory or principle of his invention consists in a method of converting all mineral, vegetable, or animal substances composed more or less of carbon, hydrogen, sulphur, or phosphorus, into bituminous or oily matter, by "saturating them by the most hydrogenous substances of mineral, vegetable, or animal origin." He then enters into a detail at large of all the substances in the animal, vegetable, or mineral kingdoms, under the three respective heads, which contain such matters, solid or fluid, as are either inflammable more or less, or any ways gelatinous, including expressly excrementitious matter of all kinds.

These substances he distils in the following manner:—Into a still, perforated at top to admit an iron rod for stirring the materials, is to be put a quantity of bituminous pit-coal, or of charcoal reduced to a powder; secondly, the like portion of soot of fossil coal, cleaned from extraneous substances and sifted; thirdly, two parts of bullock's blood, or *human excrement,* either of them in its natural state, rather than in a state of exsiccation: to this three fourths of soft or fluid bituminous matter is to be added; or of the products from the distillation of fossil coal or turf.

Previous to the distillation half the fluid bitumens used are to be well mixed with the pounded coal and the soot, and passed several times through a sieve, and then exposed to a moderate fire in the copper, and well stirred till the whole becomes an "ho-

mogeneous paste;" the blood or excrement is then to be added, along with the remaining half of the fluid bituminous matter; and then the same agitation, mixture, and heat are to be repeated, till the whole becomes an uniform substance, which may be known by the smoothness of the fracture of a part of it cooled. The still-head is then to be put on, first pouring in a tenth of the fluid bitumen. More of the fluid bituminous matter, which Mr. Denize considers as a solvent of the other substances, is to be poured in through an opening in the still-head occasionally as the process goes on, "till *the whole becomes as fluid as the dissolvent itself.*"

To promote this end, the oily matter that comes over in the distillation, which is collected in proper receivers, is added in the proportion of a tenth of the solid bases; taking care to separate it from all aqueous matter that came over with it in distillation.

Oils are also used occasionally as *solvents* in the process, and sulphur, which Mr. Denize says he can convert into "*fluid or volatile bitumen.*"

By this process are obtained pitch, tar, oil, and resin. The still is not to be filled more than two thirds, and the gelatinous matters are to be added over a moderate heat, to prevent coagulation.

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*Observation.*—Mr. Denize has mentioned several wonderful discoveries in his specification; of which the art of reducing charcoal to a fluid by a solvent, and of converting sulphur into bitumen, would be admirable, if they were proved possible.

We have endeavoured to extract something like a process, from the mass of extreme confusion and (in some parts) of contradiction, in which the specification seems involved: but we do not think this very material, as we are convinced not a single drop more oil or fluid bitumen will be distilled over by the process than what was put into the still at first.

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*Mr.* THOMAS KENTISH's *Patent for an Improvement in the Construction of Machines or Engines applicable to raising and lowering heavy Bodies. Dated February* 1806.—*Repert. Arts,* No. 49, *New Series.*

THE drawings annexed to the specification of this patent represent part of a ship, at the foot of the mast of which rests a spare yard, or derrick, projecting forward and upward obliquely; the head of this is secured to the mast by a rope, or guy, by which it may be drawn nearer to the mast or let farther off: from each of the extremities of the lower yard on the mast, ropes pass to the head of the derrick, by which it may be moved more or less to either side, as required; a wheel from two to ten feet diameter, attached to

an axis about six inches diameter, is to be fixed by iron braces any where in front of the derrick so as to turn freely; from the axis ropes pass through blocks at the head of the derrick to a hook, which is to sustain the goods when moved by it; from the wheel, which is grooved three inches deep, a rope passes to a roller sustained so as to turn by a winch at the back of the derrick; on turning this winch the rope coils round the roller, which puts the wheel and axis in motion, and the goods are thus raised by a purchase, or power, proportionally great as the diameter of the wheel exceeds that of the axis. The wheel is directed to be placed in the middle of the axis, and from each part of the axis so divided a rope passes to the hook, so that it is in part sustained by two ropes; this prevents the ropes from twisting, but is not of material use in any other respect.

The axis is made thicker in the middle and tapers off to each end, and the roller is grooved deeply in the middle to receive the rope, and has inclined planes sloping up from it to each side, at an angle of forty-five degrees; but the use of this formation of these parts is not explained. There are also drawings of two methods of fitting the same machinery to a common warehouse crane.

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*Observation.*—We can see no novelty in this arrangement of the derrick; unless it may be the attaching the roller to the derrick, instead of to the mast; but the drawings of the mode of adopting the same machinery to a warehouse crane shew that it is not in the position of the derrick or mode of working it, that Mr. Kentish supposes his invention consists; and this makes us still farther at a loss to discover the point of invention, for certainly the roller, with the wheel and axis, has often been used in cranes before, several of which construction, for example, may be seen on the custom-house quay, in Dublin, and made many years ago.

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*Observations elucidatory of the Specification of Mr. Stansbury's Patent for Locks and Keys, upon an improved Construction. By the* PATENTEE.—*Repert. of Arts,* No. 49, *New Series.*

IN this communication Mr. Stansbury mentions the superior simplicity and durability of his locks, uniting at the same time at least an equal degree of security with any in the market, and admitting of an infinite variety in the keys. The first is an object of material consequence; when we recollect how common is the complaint of locks "getting out of order," it is surely worth while to study such a construction as shall, by its simplicity, be secure from derangement. In Mr. Stansbury's lock, tumblers, wards, sliders, &c, usually employed as securities against picking, are

got quit of, and nothing is to be seen but a plane surface of case-hardened iron. The springs or pins which hold the plate are completely defended by it, and their points are all made level with its surface, so that nothing but the real key will touch them and release the bolt. Mr. Stansbury stated in his specification the infinite changes these points admit of, and which he proposes as a security against having two keys alike, an evil of the greatest magnitude; for, says Mr. S. "of what use is the most secure construction, if another person possesses a key to your lock?"

Mr. Stansbury mentions, as a farther advantage attending his invention, that of having locks in suite, with each different from the rest, and yet all opened by one master-key. This may be carried to any required extent, without any extra expense or trouble; and is effected by merely changing the order of the points.

To answer the purpose of the short bolt used as an inside fastening, Mr. S. makes a piece to turn into a notch in the common catch or spring-bolt, by which means it is held, and cannot be released from without: this may be done either by a separate knob, or by making the escutcheon turn a button within the lock: the knob is generally preferred.

These locks are to be sold by Mr. Roberts, Oxford Road, and Mr. Hewlett, in the Strand.

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*Observations.*—At the same time that we wish all possible success to this useful specimen of Mr. Stansbury's ingenuity, we must confess we doubt whether it possesses all the advantages which the patentee ascribes to it. Since the publication of our last number we have carefully examined one of the locks, from which we have obtained a far better idea of the invention, than, with all our attention, we could gather from the specification. We still cannot help apprehending that this lock is *not* "secure from derangement," and that, unless it be always used by a skilful and careful hand, it will become strained so as to "get out of order." Although the pins which hold the plate have their tops made level with its surface when locked, and although little circles are marked upon the face of the plate, to imitate the tops of the pins, yet while the former will be worn rather hollow by frequent use, the latter will become so filled with dust, oil, &c. as to cause a very manifest difference betwixt the two: in addition to this, the grooves worn and made in the plate will, we conceive, conduct to the pins; so that we think it no difficult matter for an ingenious person who has frequent access to the lock, to forge a key which shall open it; and if he have access to the machinery when unlocked, it would then be a very easy thing to prepare a key for his purpose.

The nature of Mr. Stansbury's lock will, it is true, admit of a great variety in the formation of the key; yet whenever his in-

vention gets so well known and approved as to require the speedy making of a considerable number of locks, the facility of the manufactory will hold out to him the same inducements as it does to other lock-makers to construct a number of locks and keys exactly alike: so that whether he will form a hundred alike or not two, is a circumstance which lies more in the will and determination of the manufacturer than in the nature of Mr. S.'s construction, except in so far as it admits of variety with a less effort of the mind than most other constructions.

We wish this gentleman had explained more fully his expedient for a master-key to unlock a variety of locks in suite; for, though we can see its practicability, we have not been able to devise a method applicable to this case, which we think possesses any peculiar advantages.

If, however, Mr. Stansbury's lock does not carry with it all the benefits its inventor attributes to it, still it is one of the best locks in the market; and we trust its success will be such as to reward this gentleman for his ingenuity, and induce him, by a farther attention to it, to make it yet more calculated to answer the desirable purposes which he has in view.

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# CHEMISTRY AND MINERALOGY.

*On the Tinning of Vessels, on Pewter, &c. By Prof.* PROUST.—*Journ. de Phys. Frim.* 14.

THE present experiments of Mr. P. are a supplement to the work which he published in 1803. He considers them as fully sufficient to prove the innocency of lead, when alloyed with tin, and to overthrow the prejudices which have been conceived against pewter vessels and those of tinned copper; a prejudice which has chiefly arisen from the interested views of persons concerned in other manufactures.

Lead is no otherways a poison than copper and many other substances which require oxidizement to act upon the human body. We have not only several instances of copper being swallowed without any bad effects, but Mr. Patrin has seen in Germany a founder take more than a drachm of that metal as a medicine against the rheumatism; and Mr. Rouelle shewed in

his lectures a lock of hair as green as verdigrise, which he had himself cut off the head of an aged founder. What a quantity of copper must not this old man have swallowed to produce such an effect! And do we not frequently swallow the shot which has killed our game, without any bad effects, although these shot are composed of lead alloyed with arsenic, which is surely more dangerous in theory than the alloy of lead and tin, of which one metal is confessedly wholesome.

Filings of an alloy of equal parts of tin and lead were boiled for two hours in distilled vinegar; a very small quantity of the tin was all that was taken up.

Vinegar, boiled in a saucepan, tinned with this alloy, for an hour, took up only some of the tin. Lemons, boiled with water in another saucepan, had no other effect.

Distilled vinegar boiled for two hours upon leaves of tin and of lead, in a matras, dissolved only some of the tin, and took up none of the lead.

A solution of lead in distilled vinegar being boiled upon tin foil, let fall the lead in a metallic state, so that only tin was found in the solution.

To shew the innocency even of the worst kind of tinning, Mr. P. took, for two successive days, a drachm of the alloy of lead and tin, in equal parts; from which he felt not the least inconveniency.

Lemons were boiled with water for half an hour, in a saucepan tinned with an alloy of three parts of lead and one of tin; on examining the decoction, it at first appeared to have dissolved some of the lead, as the sulphuretted hydrogen which was used to detect the presence of that metal acquired a brown colour; but this colour changed in a couple of days to yellow, and thus shewed the presence of tin only in this solution.

A pound of muriatic acid of the strength of 2° was boiled for half an hour in a saucepan tinned with an alloy of equal parts of lead and tin; on adding sulphate of potash to the acid, when cooled, a precipitation of sulphate of lead took place, but the sulphate weighed scarcely 2 grains. The muriatic solution contained a small quantity of tin.

Sulphuric acid, of the same strength, was boiled for half an hour, in the same manner; it became slightly milky, and took three days to become clear, but the sediment scarcely weighed a grain. The sulphuric acid had taken up so little tin as scarcely to afford any change with sulphuretted hydrogen. At the utmost, the quantity of acid employed for the seasoning of the victuals of a family cannot contain more than $\frac{1}{8}$ of a grain of lead, and we know that a grain even of corrosive sublimate may be taken daily, without injury; it is evident, therefore, that the use of pewter vessels and those of tinned copper is not unwhole-

some. The true source of the colics which afflict the inhabitants of Madrid is owing to the lemon-juice and verjuice sold in that city being designedly impregnated with lead.

Muriatic acid, at 10° of Beaume, boiled upon leaves of tin and of copper, in a matras, dissolved some of the tin, but not an atom of the copper, the surface of which was tinned by the metal precipitated on it. Whence it appears that acids boiled in saucepans, the tinning of which is partly worn off by scouring, do not corrode the copper, but actually repair the damage.

The use of copper vessels, or those of brass, for the preparation of preserves, or even pickles, provided they are not left in the vessel, is shewn to be innocent, not only by the experience of so many centuries, but also by the following experiment. Vinegar was boiled briskly for an hour in a copper saucepan, untinned; so little copper was taken up, that sulphuretted hydrogen did not precipitate a sufficient quantity to be weighed: the colour however acquired by the sulphuretted hydrogen appeared equal to that given by $\frac{1}{2}$ a grain of verdigrise dissolved in a pound of vinegar. As the verdigrise contained only $\frac{1}{3}$ of copper, an ounce of the vinegar, which took up only $\frac{1}{3\,2}$ of a grain of verdigrise, contained of course only $\frac{1}{9\,6}$ of a grain of copper: a quantity far too small to produce any effect whatever.

The quickness, however, with which acids take up the copper, and become highly dangerous, when they are left even for a short time in vessels of this nature, under certain circumstances, is astonishing. An ounce of distilled vinegar was poured into an untinned copper saucepan, which would hold about a pint, and whose sides were rinsed with the vinegar poured into it. At the end of two minutes, the sides were again rinsed with the vinegar, and a small quantity was poured out into a glass; the same rinsing and pouring out of a small quantity was repeated at the end of 4, 6, 8, 10, and 15 minutes. Water impregnated with sulphuretted hydrogen, on being added to the portions poured off, produced a sensible chesnut colour, even with the first portion; the shade became darker with the others; that poured off at the end of 10 minutes, being as dark as the decoction of coffee, and the last still darker.

The golden colour which copper acquires by vinegar passing over it, is well known, and arises from the real colour of the metal being seen through a coating of the orange yellow oxide ad minimum; which afterwards changes to a dark brown, the oxide becoming oxidized ad maximum. Common salt is also decomposed by the contact of copper, and is changed into a muriate of copper with minimum of acid, which is highly dangerous. During this decomposition, it appears that the soda is disengaged, as the solution renders violets green.

Fats of all kinds act upon copper, when aided by the oxygen

of the atmosphere; and it is to the united agency of the tallow used to the bottom of ships, and the salt of the sea, that the rapid destruction of copper-sheathing, in certain cases, may be attributed: this destruction has been remedied by putting paper between the copper and the tallow.

Copper vessels untinned may therefore be safely used in manufactories where acid fruits or vinegar are only to be briskly boiled in them, and immediately poured out; but for domestic uses, as the processes of the kitchen frequently require a long-continued slow digestion, the tinning of the vessels is indispensable.

Much alarm has been created at Madrid, respecting the pewter vessels used by those who sell lemonade; the preceding experiments, in regard to the alloy used in tinning copper vessels, are sufficient to shew the groundlessness of these apprehensions. The lemonade for sale is made by squeezing two lemons (yielding about 13 or 14 drachms of juice each) into 4 pints of water. The vessels used for keeping it are either of pure tin, or an alloy of tin with lead, in different proportions. No regular system of assay being established by law, the only method of knowing whether the composition of the vessel is agreeable to the stamp, is by a reference to some other pewterer; a mode of decision which is liable to abuses.

Two ounces of a mixture of equal parts of lemon-juice and water, were put into vessels, one made of pure tin, and others of an alloy of tin with lead, the lead being in the proportion of 5, 10, 15, 20, 25, 30, and 50 per cent. The liquor was left in them for 24 hours, care being taken to wash the sides of the vessel frequently with it, by means of a feather. In the vessel of pure tin, and those of 5, 10, 15, 20, per cent. of lead, the oxide that was formed rendered the liquor milky. None of the liquors shewed the least signs of lead when examined by sulphate of potash; but they all contained tin in solution; and the oxide that rendered the liquor turbid, was a pure oxide of tin. Common lemonade gave similar results.

The lemonade which had remained in the vessel of pure tin, produced the same chesnut colour with sulphuretted hydrogen, as that which had remained in the vessel which contained 50 per cent. of lead; hence it plainly appears that this colour was due to tin and not to lead. Indeed it is evident, from the whole of these experiments, that neither lead nor copper can be taken up, as long as tin is present, on account of the superior attraction it has for acids.

Since the presentation of this essay to the Spanish government, it has appointed Mr. Domingo Fernandez, and Mr. Antonio Cruz, to settle definitively whether acids took up the lead contained in pewter, and became unwholesome. Their experiments

were made upon those vessels which had been seized upon the representation of certain pewterers. They chose those that appeared the most highly alloyed with lead, and which were the most damaged by moisture. Neither vinegar, verjuice, the juices of lemons, oranges, cherries, or gooseberries, sour milk, &c. dissolved any lead that could be discovered by sulphate of lead, water impregnated with sulphuretted hydrogen, hydrosulphurets, &c. Most of these liquors took up a little tin, but some did not take up any. In consequence of the report of the above chemists, all the vessels were restored to their owners.

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*Facts relative to the chemical History of Silver. By Prof.* Proust. —*Journ de Phys. Mars,* 1806.

Muriate of silver is soluble in muriatic acid; it separates in octaedral crystals. This solution is decomposed by the addition of water, the muriate being precipitated.

Muriatic acid poured upon refined silver, converts it into muriate of silver; a gas which can only be hydrogene, escapes. The acid, although weakened, retains little or nothing in solution; for it is scarcely altered in colour by hydrosulphuretted water.

Bergmann said, muriate of silver contained 75 silver and 25 acid; the moderns repeat this assertion, and forget the oxygene.

Muriate of silver does not penetrate the crucibles in which it is melted, nor even attack them. Nor is it volatile, although at first, while moist, it yields a vapour which condenses into a white farinaceous sublimate like arsenic. Melted in a glass retort, it did not attack the vessel, nor yield any sublimate. By fusion it becomes transparent, and has a peculiar pearl grey colour, similar to that of the native muriates. It has a strong tendency to crystallize in octaedral crystals.

The solution of this muriate in ammonia, deposits octaedral crystals. This solution may be preserved for years without decomposing; but it forms by a very slight heat the fulminating oxide. Mr. P. evaporated some of this solution, intending to collect the muriate; a few grains were deposited, when upon raising up the capsule, these grains detonated, and threw the liquor over him. A face spotted with black for several days, was luckily all the injury he received.

To exhibit the muriate to advantage in giving lectures, it should be poured when slightly red into a silver bason, and swung round, so as to form a thin plate, which is flexible, transparent, and may be cut, like the horn leaves used for lanterns. If it is left to cool in the crucible, larger masses may be obtained; which might be turned, and formed into toys; but the light renders them brown, which diminishes their value.

Kunkel's method of reducing the muriate by melting it with three times its weight of lead is very expeditious; but the product must be cupelled; and Mr. P. has never been able to recover the whole of the silver: he is doubtful whether this is not owing in part to the volatilization of the muriate of lead. The reduction of the muriate by carbonate of potash is very embarrassing, on account of the swelling of the mass, which sometimes occasions a great loss of the silver. Caustic potash has not this inconvenience, but it is too dear.

Mr. P. prefers the method of Sage, which consists in boiling the muriate of silver along with water, and some pieces of iron, in an iron vessel; the water being changed, the silver is left in form of a powder, which ought to be washed, and remelted with a little saltpetre and borax to free it entirely from the iron. The completeness of the decomposition may be known by exposing the powder to the sun; for if any muriate of silver remains, it will become of a violet colour. By this method he lost only 4 grains in 1600 of muriate.

The silver separated from the muriate by potash is not always pure. Mr. P. observed it to split into leaves under the hammer, which he found to be occasioned by some undecomposed muriate that remained united with the silver.

The muriate of silver is found native, either in detached portions, or disseminated in native silver, in the sulphurets of silver, in the carbonates of silver or of lime, and even in siliceous stones. Mr. P. has a specimen of the pure muriate about 10 ounces in weight. It is transparent, pearly, and sectile. Exposed to the sun, fresh surfaces of it become violet in a few minutes; it melts without altering its appearance or losing any of its weight. Exposed to the flame of a bougie it runs, and forms red drops, which become white on cooling, as is the case with the artificial muriate. The native muriate, when found united with carbonate of silver, forms a grey ore, which is very difficultly frangible; and on rubbing shews its silver.

Silver, at a certain temperature, is capable of changing the oxide of iron ad maximum into that ad minimum; but at a less temperature the oxide of iron recovers its oxygen. For a solution of the red sulphate being heated along with silver (or even in a silver capsule), a part of the silver is dissolved, and the sulphate becomes red. If the silver is separated by adding common salt, and filtrating the liquor, the solution gives a green precipitate with the alkalies; but if no salt is added, and the liquor is only filtered, it lets fall, on cooling, the silver in metallic flakes. The green sulphate of iron, poured into the sulphate of silver, precipitates the latter metal in the form of a brilliant powder. The carbonate of silver, obtained by means of the carbonate of potash, is of a yellow white; but it grows black by the action of light,

and loses its oxygen. At the end of a year it even leaves a portion of metallic silver, on being treated with very weak nitric acid.

Quicksilver, poured into the sulphate of silver, produces a crystalline precipitate, which scarcely rises above the surface; as that formed by quicksilver in the nitrate does.

Distilled vinegar readily dissolves the oxide of silver; the solution is easily crystallized, and yields long white needles. By distillation it gives out radical vinegar and gas, charcoal is left, and the silver is reduced.

Mr. P. inserts a notice by Mr. Fernandez. This gentleman having used in the operation of quartation and parting, silver reduced by means of potash and charcoal from the muriate of silver, was surprised to find his assays for the value of some gold coins better than he expected. On dissolving the gold which had been assayed in aqua regia, it let fall a white powder, which was muriate of silver. Hence he thinks, it is necessary to dissolve the grains of gold left in the operation of parting, whenever there is reason to suspect the presence of muriate in the silver.

Nitric acid distilled upon silver, carries off some portion of it, however moderate the ebullition; as may be discovered by pouring muriatic acid into the distilled liquor, and the assay of silver ores, by boiling them in nitric acid, is of course uncertain. Nitrate of silver may be kept melted for some time without losing more than $\frac{1}{100}$ of its weight; when decomposed by the heat being augmented, it yields 64 per cent of silver. 100 of silver requiring $9\frac{1}{2}$ or $9\frac{3}{4}$ of oxygene to combine with the nitric acid; hence the nitrate consists of 69 or 70 of oxide of silver, and 31 or 30 of nitric acid.

In precipitating nitrate of silver by copper, some of the silver always remains in the solution; which appears on the addition of muriatic acid. The assay of ores, therefore, by this means, although much used, is imperfect; for an ore which yields 10 per cent. by fusion and cupellation, will give only $8\frac{1}{2}$ or 9 by precipitation; and the assay, by the quantity of muriate precipitated, requires troublesome reductions: the dry method is of course preferable. Mr. P. recommends the following method proposed by Sage.

An assay cwt. of calcined ore is to be melted with as much litharge, and three cwt. of common potash, in a crucible, lined with charcoal moistened with a little oil. If the assay is successful, the lead obtained from two parcels of ore, ought not to differ more than 2 lb.; and the buttons obtained by the cupellation to which the lead must be subjected, ought not to differ more than an ounce. If the mine is so poor as to give less than an ounce, 400 real grains of the ore must be taken.

Nitrate of silver ad minimum, may be prepared by boiling a saturated solution of silver upon silver precipitated by copper, and continuing the boiling for an hour after the emission of the ni-

trous gas has ceased. The silver ought previously to have been purified by boiling in a saturated and slightly diluted solution of silver, which takes up the copper, and leaves the silver so pure, that it does not alter the colour of fresh nitrate of silver.

The nitrate ad minimum is clear yellow, not changeable; it may be concentrated much more than the nitrate ad maximum, without crystallizing. When its specific gravity is 2.40, it shews no signs of crystallization, even when cold; but on pouring it out of the retort, it congeals so fast, that the last portions hang like icicles to the neck; much heat is emitted during this solidification. During the concentration, some pieces of silver should be added. Some of the nitrate is volatilized, and this portion is sometimes a nitrate ad maximum, and at others a mixture of the two, as appears on the addition of ammonia.

It is extremely difficult to get any perfect crystals of this nitrate, as it congeals so suddenly; if sufficiently concentrated when congealed, it cannot be dissolved in water without decomposition, a yellow powder precipitating; and if the water is acidulated, although this yellow powder is taken up, the nitrate is altered; a part of the silver becoming oxidized ad maximum. This yellow powder is a nitrate of silver, in which both the oxide and the acid are ad minimum; and is formed by this portion of the oxide having yielded its acid to the other which is dissolved. The nitrate ad minimum may however be crystallized, by stopping the distillation every now and then, so as to find by trial the precise time.

A solution of the nitrate ad minimum exposed to the air, loses its colour; and yields, in a few days, large square plates of the nitrate ad maximum. Nitric acid dropped into the solution, immediately produces similar crystals; the solution becomes yellow (we rather suppose white), and at last is entirely the nitrate ad maximum. If the mixture is heated, nitrous gas is disengaged.

Muriatic acid poured into the solution, yields a muriate of silver with the oxide ad maximum; nor has Mr. P. been able to form muriate ad minimum.

The nitrate of silver ad maximum has no effect upon infusion of litmus; that ad minimum forms a blue precipitate.

The nitrate ad maximum gives a scarlet colour with cochineal; that ad minimum forms a deep violet lake.

The nitrate ad maximum has no effect upon the solution of indigo in sulphuric acid; that ad minimum takes away all the colour, and the silver is precipitated in a metallic state.

The nitrate ad maximum has no effect upon the tincture of the fecula of water-hemlock; that ad minimum changes its colour from feuille morte to a fine green.

Ammonia precipitates the nitrate ad minimum of a black colour; this precipitate is pure silver: it does not fulminate, however long it may be kept under the ammonia. The remaining

solution holds an oxide ad maximum in solution; for if it is saturated with weak nitric acid, it no longer becomes black by the addition of ammonia. Hence the portion precipitated, gave up its portion of oxygene to that which remained dissolved.

Pure potash produces a brown precipitate in the nitrate ad minimum, of the same shade as that from the other nitrate: this precipitate being redissolved in nitric acid, is precipitated of a black colour by ammonia, and did not, of course, change its state of oxidizement; but by drying it becomes oxidized ad maximum.

Alcohol separates from the nitrate ad minimum, the same yellow powder as water does; the remaining solution being distilled leaves nitrate ad maximum and metallic silver. The alcohol is not converted into ether, any more than when it is distilled with the nitrate ad maximum, which it dissolves very well.

The nitrate ad minimum, dropped into boiling water, produces three successive changes of colour; viz. yellow, red, and black. If while the liquor is yellow, or red, a few drops of acid are added, it becomes clear, and all further change is prevented; but when the liquor is become black, an addition of acid does not render it transparent. The black powder is silver, and, of course, requires a strong acid; it silvers the sides of the glass as it falls. All these phenomena do not take place if a little acid is added to the nitrate.

Mr. P. observes, that water distilled off the yellow nitrate of quicksilver ad minimum, carries over some metallic quicksilver.

A dilute solution of nitrate of silver ad minimum does not become more oxidized by the action of the air, unless very slowly.

Solutions of nitrate or sulphate of silver do not attack carbonate of copper, nor become coloured; the nitrate ad minimum has no more action in this respect.

The yellow powder (or nitrate of silver ad minimum with a defect of acid) soon changes colour in the air, and becomes covered with a black powder, which is pure silver.

The nitrate ad minimum when distilled, becomes thick, emits a little nitrous gas, melts, and yields a yellow sublimate; that ad maximum does not yield this product. The melted mass, when dissolved in water, lets fall the yellow powder, mixed with some silver powder; so that it appears that one portion of the nitrate ad minimum did not change its state of oxidizement, and that the other was turned into nitrate ad maximum.

Nitrate of lead, treated with more lead, gave results nearly similar; of these Mr. P. means to treat hereafter.

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*Facts relative to the chemical History of Gold. By Prof.* Proust. —*Journ de Phys. Mars*, 1806.

Mr. P. has found great difficulty in determining the quantity of oxygen which gold takes up when dissolved in acids.

Six hundred gr. of muriatic acid at 12° Baume, and 200 of nitric acid at 40°, dissolved by the help of heat 144 gr. of gold; 200 gr. more of muriatic acid being added, it took up 43 gr. more of gold. To obtain crystals, it is best to use more gold than the acid will take up, and to add successive portions of muriatic acid till no more of the metal is dissolved. The crystals are lamellar, and very fusible; in hot weather they become liquid in the middle of the day, and crystallize again at night. Their taste is astringent and somewhat bitter, without any metallic after-taste. They are soluble in alcohol; which being distilled off, is not changed into ether, and leaves the muriate unaltered. By distillation, the crystals yield water, and oxygenized muriatic acid; the gold remains with a spongy texture and of a dull aspect. Some little of the gold is carried over.

Sulphuric ether poured on a solution of gold, takes up the muriate, and leaves the nitric acid: the crystallized muriate is entirely soluble in ether. On exposure to air, the ether is volatilized, and the muriate is left pure, as a yellow acerb liquor. The ether becomes saturated with the muriate by renewing the solution of gold; when highly charged, it sinks to the bottom of the nitric acid, and appears like oil of cinnamon. Mr. P. was not able to gild steel with this ethereal solution, although it has been repeatedly proposed year after year for this purpose, and as often found ineffectual. He tried the plunging of the steel immediately in water, but the gold wanted lustre, and did not adhere well when dried; even a strong heat applied to them had but little effect in increasing the adhesion. The highest charged ether he could make, did not deposit a sufficient quantity of gold to cover the blackness produced by the corrosion of the steel.

Gold precipitated by sulphuretted hydrogen, is only a mixture of gold and sulphur, which may be separated by distillation.

Sulphureous acid precipitates gold in its metallic state; but in such extremely small particles, that Mr. P. thinks they might be useful in gilding, or in enamel painting. The particles soon coalesce into a spongy tenacious body, which is useless in these processes.

Sulphate of iron precipitates gold in form of a fine purplish red powder. If it is washed with acidulated water to take away any iron it may contain, and then kept under water, it is a convenient form for procuring a speedy dissolution of gold; when this powder is burnt in upon porcelain, it produces a deep purple colour. Muriatic acid at 12° boiled upon this powder, dissolves some of it, and becomes yellow; a piece of tin put into this solution immediately produces a purple colour. Nitric acid at 40°, boiled upon this powder, also dissolves a part, and becomes coloured; with acid at 36°, some is taken up, but so little that it can scarcely be discovered by tin. It is doubtful whether nitric acid at 32° will take up any gold, and especially in parting, as the gold is then not so minutely divided.

Water charged with phosphuretted hydrogen precipitates the solution of gold; even that which has stood over phosphorus will do the same, owing however to the gas it has absorbed; for phosphorous acid requires 10 or 12 hours to act upon this solution.

Pure potash precipitates gold in form of a yellow powder, then violet, if the solution was very dilute, but which becomes black when it is washed and dried. It is extremely difficult to attain any certainty as to this precipitation; and the solution always retains some of the gold, which frequently separates the next day, and either forms a metallic pellicle, or even gilds the vessel in a very brilliant manner. The black precipitate is a mixture of oxide and pure gold; muriatic acid dissolves the oxide, and leaves the gold untouched. Nitric acid at 40°, and aided by heat, has a very slight action on the oxide; the acid becomes yellow, and water separates the oxide, which then appears like aurum fulminans: this oxide is taken up by muriatic acid with the greatest ease.

Dilute sulphuric acid dissolves the black precipitate, but takes up less than the muriatic; a violet colour is produced in it by a few drops of muriate of tin.

The alkaline carbonates are equally ineffectual in producing a homogeneous precipitation of gold, or its oxide.

One hundred parts of aurum fulminans, decomposed by sulphuretted hydrogen, leave 73 of gold. Orschal used aurum fulminans to tinge glass of a purple colour. When moistened with muriate of tin, it is changed into the purple powder of Cassius.

Solution of gold dropped into nitrate of quicksilver ad minimum precipitates a violet powder, which produces a very fine purple colour: this purple is a mixture of gold, and mild muriate of quicksilver, which may be separated by sublimation. But if the nitrate of quicksilver is dropped into the solution of gold, the gold is precipitated pure, the mild muriate of quicksilver which is formed being immediately decomposed. In like manner mild muriate added to the solution, throws down the gold, and is retained in solution, being changed into corrosive muriate.

Nitrate of quicksilver ad maximum also precipitates the muriate of gold, with several remarkable circumstances. The solution of gold dropped into a nitrate of quicksilver (prepared by dissolving the red oxide of quicksilver in nitric acid, and diluting the solution with 8 or 10 times its weight of water) throws down a yellow precipitate similar in appearance to aurum fulminans. On continuing the addition of the solution of gold, it ceases at last to render the nitrate turbid. At this period the nitrate is become corrosive muriate of quicksilver, which does not precipitate the muriate of gold. But if the nitrate of quicksilver was not completely oxidized ad maximum, some mild muriate would be formed which would unite with the precipitate that falls down. This yellow precipitate is not a pure oxide, but contains some

corrosive muriate of quicksilver, which Prof. P. was not able to separate by repeated washings. One hundred parts of it when dried, being heated in a retort, yielded 8 of water, 16 of corrosive muriate mixed with the mild muriate, and 70 of gold; the remaining 6 may be supposed to be the weight of the oxygen separated: so that upon this supposition, gold takes up 8.57 per cent. when it becomes oxidized.

On repeating the experiment, different appearances were observed. The precipitate was washed still more carefully than the last, yet the last washings were rendered turbid by the muriate of tin ad minimum; 100 gr. heated over a lamp, almost immediately threw out with great force, a quantity of white vapours; these appeared to be owing to the rapid disoxygenizement of the metal, which remained in a pure metallic state: the retort was covered with mild muriate of quicksilver mixed with the corrosive muriate. The precipitate was then flung by degrees into a matras placed over a lamp, to avoid the too rapid progress of the former experiment: by this means, 100 parts of it yielded 58 of gold, and 16 of the two muriates of quicksilver: of the remaining 26 parts we may suppose 8 to be water as before, which leaves 18 for the oxygen, so that upon this supposition 106 of gold takes 31 of oxygen to form its oxide. This proportion Prof. P. thinks is more accurate than the former, because he then boiled the precipitate in water, which might disoxigenize some part of the metal: in the latter experiment he avoided that source of error. Prof. P. is also decidedly of opinion that the mild muriate of quicksilver, which is combined with the oxide of gold in this precipitate, does not come from any oxide ad minimum that his nitrate of quicksilver contained, although he does not determine the complicated attractions which turn the corrosive muriate into mild muriate and attach it so strongly to the oxide of gold.

This precipitate heated upon a piece of paper over a wax taper, melts and is scattered about, by emitting white puffs, before it is reduced to a pure metallic state. If it is triturated along with sulphur and then gently heated over the taper, it detonates, and gives the same kind of loud report as aurum fulminans. The first precipitate he prepared (by boiling in water) detonated as well as the other. Oxide of gold prepared by pure potash, when mixed with sulphur, and heated, has not the least tendency to detonate. If the other precipitate is scattered about the paper it detonates successively, but the detonation is instantaneous and violent if the precipitate is properly collected together. After the detonation, gold, in minute particles, is left upon the paper. It is remarkable that this precipitate is made to detonate by the very means which deprive aurum fulminans of its detonating quality, and also that as ammonia is not present in this precipitate, the explanation of the detonation it produces, and also that of aurum fulminans, require some consideration.

As to the purple powder of Cassius, it is no longer doubtful that the gold it contains is in the metallic state, because the experiments of Pelletier have demonstrated, that tin, or its oxide ad minimum, applied to the muriate of gold, can produce no other effect; but as it certainly contains a portion of oxide, it has been generally supposed to be an intimate mixture of metallic gold and oxide of tin. The difficulty however of separating these two ingredients shews that this powder is something more than a mixture.

To analyze the purple powder of Cassius, nitro-muriatic acid must be used, as the nitric or muriatic acid have, when used separately, but a very slight action on the powder. It immediately loses its colour, yields a solution of gold, and leaves an oxide of tin; this oxide being heavy, sandy, and transparent, like pounded glass, is evidently the oxide ad maximum. It might be supposed that the nitric acid used might reduce the tin to this state; but the oxide separated by heating the purple powder in muriatic acid is equally glassy in its appearance, its solution also does not any longer precipitate that of gold, and it forms a yellow precipitate with water impregnated with sulphuretted hydrogen.

To shew that the oxide of tin ad maximum must be chemically united to gold in the purple powder, it is necessary to consider that although the oxide of tin ad minimum loses, according to the general property of metallic oxides, some of its solubility when it becomes oxidized ad maximum, it still remains very soluble in nitro-muriatic acid, and in muriatic acid. But a single drop of muriate of tin ad maximum, although highly acid, being let fall into a solution of gold, which is always surcharged with acid, immediately produces the purple precipitate. This precipitate is very different from the coloured powders formed by the sulphurous acid, the phosphorous acid, the sulphate of iron, &c. So that it is evident that the purple powder is formed by some very strong attraction between its constituent parts, especially when we consider that the acidity of the mixed solution increases as the powder falls.

Ammonia immediately dissolves the fresh prepared purple powder, and the solution is of a lively and deep purple. It passes unchanged through filtres; water does not decompose it, as is usually the case with the ammoniacal solutions of metallic bodies; if indeed the purple powder is taken in excess, some of it separates. Distillation also separates the purple powder, but if the residual liquor contains ammonia, some of the powder is retained in solution: acids also precipitate it from the ammoniacal solution.

Precipitates consisting of metallic gold are not soluble in ammonia; the oxide ad minimum is also very imperfectly soluble, the solution being always milky: hence the purple powder, which has of course properties different from those of its component

parts, must be a true chemical combination. It is indeed very singular that a metal which is so very limited in its attractions should unite with another metal, whose attractive powers are diminished by being oxidized ad maximum; but the same singularity is to be found in aurum fulminans, which although only a combination of the oxide of gold with ammonia, is not decomposed by any acid or even alkali.

Quicksilver does not separate gold from the purple powder. The purple powder is not a mere mixture of gold, as precipitated by the sulphate of iron, along with a white oxide, for that precipitate has only a purple tint in some particular points of view; whereas the purple powder retains its colour in whatever direction it is viewed. All gold which has been precipitated in a metallic state by sulphate of iron, by phosphuretted hydrogen, by sulphurous acid, &c. appears blue when the vessel is placed between the eye and the light, but in a contrary position the peculiar aspect of gold is visible; the purple powder has a deep body, and no metallic appearance on whatever side it be viewed; its colour is the same as the colour of its solution in ammonia, only more intense.

Muriate of iron also precipitates the solution of gold, but the oxide of iron ad maximum does not contract any union with the gold as it falls; the combination therefore of the oxide of tin with the gold in similar circumstances is owing to a peculiar attraction. The purple powder also may be applied to silk, which it tinges of a violet colour: this can scarcely be owing to a powder of gold being incorporated with the filaments.

The excess of the acids occasions a retardation of the deposition of the purple powder, which becomes by this means excessively slow. Muriatic acid shook up with fresh washed powder, appears to dissolve it, especially if the mixture be heated; but although this apparent solution is transparent, the powder is left behind on filtering it.

The precipitation of the purple powder may be abridged by pouring pure potash by successive portions into the mixed liquor. If the edge of the liquor does not become clear in a few minutes, more of the potash may be added: the purple powder forms itself into flakes, and falls down. Too much potash must not be added, otherwise the excess will decompose the free muriate of tin which is held in solution, and throw down an oxide of tin as well as the true purple powder.

One hundred parts of well-dried purple powder put into a very weak aqua regia made of muriatic acid at 4 or 5°, and a few drops of nitric acid, loses its colour, and gives a solution of gold; which when precipitated by sulphate of iron yields 24 of melted gold: 70 parts of oxide of tin are left in the residuum, so that 6 have been taken up by the acid. This residuary oxide is white and glassy being oxidized ad maximum. Hence the gold in the

purple powder has united with 3 times its weight of oxide; and as 76 of the oxide ad maximum are equal to 72.5 of the oxide ad minimum, it is probable that this is the quantity of the oxide ad minimum which combines with the proportion of oxygen required to oxidize 24 parts of gold.

When muriate of tin ad minimum is poured into nitro-muriatic acid the oxide is changed into that ad maximum; but no precipitation takes place, not even by the help of heat. Muriatic acid at 10°, boiled on the purple powder, slowly decomposes it, and leaves the gold in small lumps: the solution is slightly yellow, it contains the oxide of tin ad maximum: a piece of tin put into this solution destroys the colour, but does not produce the slightest shade of purple.

Nitric acid at 32° takes away some of the tin from the purple powder, and enlivens the colour of it, so as to approach that of vermilion; but however long the acid is boiled upon it, the gold is never left perfectly pure. The nitrous solution contains oxide of tin ad maximum, and a little gold, as is evident if a few drops of muriate of tin be added to it.

Liquid sulphurous acid also enlivens the purple powder, by abstracting some of the tin, but has no further action upon it.

Sulphate of tin ad minimum also precipitates gold from its solution in the form of the purple powder of Cassius.

Gold unites with extractive and colouring matters, so as to form frequently very beautiful lakes.

Solution of gold poured into a well-filtered solution of dragon's blood threw down a lake: 100 parts of this lake, after being dried, was burnt, and the ashes melted with borax; 40 of gold were produced. This lake is not altered either by water or alcohol. Pure potash takes up some of the colouring matter, but only improves what it cannot dissolve. Ammonia discolours this lake, but does not dissolve it. Muriatic acid at 10° has not the slightest action on this lake, not even when fresh: nitric acid decomposes it. From these facts it is evident that it is a true chemical combination of gold in its metallic state, with a colouring matter.

The infusion of pine-bark, which is used in Spain to tan leather, produces with a solution of gold a similar kind of lake, which agrees in its properties with the former, but contains only 26 per cent. of gold.

The artists of the last century used not only the purple powder of Cassius to tinge glass, or enamel, of a purple colour, but also aurum fulminans, the precipitate formed in the solution of gold by the liquor silicum, the oxide prepared by the help of tin or quicksilver, the powder procured by rubbing the metal with pumice-stone, and indeed every kind of oxide of gold, as well as gold which had by any mode been minutely divided. As gold has been shewn to exist in its metallic state in the purple powder, and this metal tinged the capsule in which it was evaporated by

the concentrated solar rays, of a purple colour, and also stains the glasses upon which it is exposed to the electric shock of the same colour, it becomes important to inquire in what state it exists when it thus stains vitreous compositions of a purple colour.

Silver is not capable of being oxidized by the bare action of air aided by heat, and when oxidized by acids it recovers its metallic form with great ease; but when a vitrescent body is present to dissolve the oxide as fast as it is formed, and before it is destroyed, the oxide incorporates with the fritt, and is not reduced without a very violent heat. Prof. P. thinks that a similar explanation might perhaps be given of the effects produced by gold or its oxides in vitreous compositions; but the colour given by gold has some remarkable habitudes. Any precipitate of gold melted with a fritt of easy fusion yields a very transparent and colourless glass: if pieces of this glass are heated in a close vessel they become of a fine purple colour, without losing their transparency. Purple enamel loses its colour and recovers it again with great ease. Hence it is evident that this purple colour from gold is not yet properly explained; and that every thing shews more and more the property which gold possesses of forming combinations different from those of other metals.

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*Observations.*—This paper, like the preceding one, on silver, is so rich in facts, many of which are new, and others tend to correct long established errors, that they both merit the most serious attention from chemists, and artists. Although gold has always been a favourite object of research among chemists, Mr. P. plainly shews that its properties are yet far from being understood.

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## *On the Discovery of Palladium. By Dr.* Wollaston.—*Phil. Trans.* 1805.

Among the grains of platina there occur other grains which so strongly resemble them, that they can scarcely be separated but by their insolubility in nitro-muriatic acid. These grains are harder to the file than those of platina, they are not malleable, they are lamellar and have a brilliant fracture, a circumstance which sometimes enables a person to detect them. Their specific gravity is 19.5, while that of crude platina never exceeds 17.7. They appear to consist of iridium and osmium; but as the specific gravity of the powder left in dissolving crude platina is at the utmost 14.2, Mr. Tennant has undertaken a more complete examination of them.

There are also found mixed with the grains of crude platina, minute red crystals, so small that 100 of the largest scarcely weigh $\frac{8}{100}$ of a grain. The specific gravity of these crystals is considerable. They lose their colour on heating. They barely scratch

quartz, and their hardness is inferior to that of the topaz. In their form they so agree with that of the hyacinth or jargoon, that Dr. W. has no doubt of their being that stone.

In the examination of the solution of crude platina, after as much as was possible of the platina had been precipitated by sal ammoniac, another precipitate was obtained by means of iron. This precipitate, called by Dr. W. the first metallic precipitate, was again dissolved, and more platina was precipitated by sal ammoniac: this precipitate was not so pale a yellow as before; but its impurity was scarcely discernible when reduced. The solution was then neutralized with soda, and the gold, mixed with the grains, was precipitated by green sulphate of iron. Bars of iron being again employed threw down a second metallic precipitate; which was intended to have been again treated by solution and precipitation, but part of it resisted the action of the nitro-muriatic acid, and has since been found to be rhodium. The solution was very dark coloured; sal ammoniac produced only a slight precipitation of a deep red colour; this has since been discovered to be occasioned by iridium. The solution still retained its dark colour, and was precipitated by iron; a great part of the third metallic precipitate thus procured was rendered insoluble in fresh acid, for the same reason as before.

Muriatic acid poured on the second metallic precipitate, took up some lead, iron, and a small quantity of copper. Dilute nitrous acid took up more copper, and formed a fine blue solution. Concentrated nitrous acid formed a dark brown solution; a clean plate of copper precipitated a black powder, which adhered to a surface of platina, on which the solution was placed. Hence Dr. W. suspected some new metallic substance. Quicksilver agitated with the solution, formed an amalgam; which on being exposed to a red heat, left a white metal infusible by the blowpipe. This metal gave a red solution as before in nitrous acid; it was not precipitated by sal ammoniac or by nitre; but by prussiate of potash it gave a yellow or orange precipitate; and it was precipitated by quicksilver, but not by silver. By these properties, Dr. W. originally distinguished palladium as a distinct metal.

The precipitation from nitrous acid by quicksilver was irksome and imperfect; as the nitrous acid did not seem to take up all the palladium, nor the quicksilver to precipitate even all that was taken up. Potash, added to the nitro-muriatic solution of palladium, forms a very soluble triple salt; while the triple salt of platina, formed in the same manner, requires a considerable quantity of water for its solution; hence nitre added to muriatic acid, is unfit for the solution of platina, but freely dissolves palladium. It is equally fit for the solution of gold.

One part of nitre was dissolved in 5 of muriatic acid, diluted with an equal quantity of water. This solvent poured on the

second metallic precipitate, decanted and evaporated, yielded crystals which were green when viewed transversely; red when viewed in the direction of their axis; and whose general aspect when large was dark brown. From these crystals, purified by a second crystallization, palladium may be precipitated nearly pure, by iron or zinc: the remaining impurity may be removed by digestion in muriatic acid.

That palladium was a simple metal appeared from its forming a distinctly crystallizable triple salt with muriate of potash, its separability without any change from the alloys formed by it, and the facility whereby the precipitates formed by its solution were reduced by mere heat. But as it might be supposed to be a compound of a known metal with some fixed acid (as was the case with siderite), Dr. W. attempted to decompose it by various processes, but without effect.

This metal is easily separated from the nitro-muriatic solution of the ore of platina, if prussiate of quicksilver is added to it; as the prussiate of palladium is slowly precipitated of a pale yellowish white, which is reduced by heat and yields pure palladium, weighing about $\frac{1}{200}$ part of the weight of original ore. The quantity of palladium is not increased by augmenting the quantity of prussiate of quicksilver, nor could any precipitate be obtained by the same means from platina. The great attraction of prussic acid for quicksilver, prevents the precipitation of iron or copper; and the precipitation itself is promoted by the attraction of prussic acid for palladium, as the prussiate of palladium may even be formed by boiling a precipitated oxide of this metal in prussiate of quicksilver.

Prussiate of quicksilver is consequently a good test of the presence of palladium; but it is to be observed that the precipitate has not always the same properties. When it is procured from a neutral solution in nitrous acid, it detonates when heated to about 500° Fahr. The noise is similar to that of an equal quantity of gunpowder, and the explosion is not attended with any marks of violence unless it is confined. A very feeble light is produced, which is visible only in the dark.

Palladium is very slowly dissolved in strong colourless nitric acid; the acid surrounding the metal soon acquires a red colour, but no gas is disengaged. The same acid previously impregnated with nitrous gas had a much more powerful effect.

Silver, copper, palladium, and platina, were each of them laminated so thin as to weigh 10 grains to the square inch. Slips of these metals 4 inches long, and $\frac{4}{10}$ inches in breadth, were coated with wax. One extremity of these slips was heated so as to be visibly red, and the wax upon the silver was melted as far as $3\frac{1}{4}$ inches, that on the copper $2\frac{1}{2}$ inches; on the palladium and platina the wax was only melted for 1 inch.

A slip of platina and palladium being rivetted together, and then

heated, became concave on the side of the platina, and thus shewed the expansion of palladium by heat was rather more than that of platina. By a similar method, Dr. W. found platina to expand less than steel. It is known that steel expands in passing from the temperature of freezing to that of boiling water, 12 parts in 10.000 of its length. Dr. W. estimates the relative expansion of palladium at 10, and that of platina at 9.

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*Chemico-galvanic Observations. By* L. Brugnatelli.—*Journal de Phys. Avril,* 1806.

Mr. Simon, of Berlin, was the first that obtained muriatic acid by galvanism: his experiments are related in Gilbert's Annalen der Physik, 1801. Two tubes, closed at one end and filled with distilled water, were closed and connected by muscular fibres; they both communicated with the pile by means of gold wires which passed through the stopper. In 24 hours the water which was immediately connected with the zinc pole had a yellow tinge, the odour of oxygenized muriatic acid, and had destroyed the colour of the stopper. It reddened tincture of litmus, and effervesced with carbonate of potash, changing that salt into one which yielded cubical crystals that decrepitated on burning coals, and precipitated the nitrate of silver. Hence it is plain that not only muriatic acid was procured, but also oxygenized muriatic acid, which dissolving the gold wire, produced the yellow colour.

Mr. Simon having some suspicion that the animal matter with which his tubes were closed furnished the muriatic acid, employed (in order to avoid the use of cork, charcoal, or plumbago) a tube in form of a V, which communicated with the poles of a pile by means of a gold wire in each branch. This experiment was unsuccessful, as he did not procure any muriatic acid in the branch communicating with the positive pole.

Cruikshank galvanized a solution of muriate of lime by means of a gold wire connected with the positive end of a pile. When the galvanic circle was completed, the water was decomposed, the residuary liquid was yellow, the wire was acted upon, and the solution had the odour of nitro-muriatic acid. A wire of platina produced the same smell, although it did not seem to be acted upon. Cruikshank supposed the muriate was decomposed; a slight yellow precipitate is always thrown down in this experiment, which has been supposed to be lime; but this precipitate, Prof. B. says, is really oxide of gold, and therefore the oxygenized muriatic acid which acted upon the wire was formed *de novo*.

Cruikshank also obtained oxygenized muriatic acid by plunging a gold wire connected with the pile into a solution of mu-

riate of soda: as this salt is not decomposed by galvanism, the oxygenized acid must have been formed *de novo*, as the former. Prof. B. has found that this acid may also be formed in a similar manner in solutions of muriate of potash and of muriate of ammonia.

The formation of muriatic acid in saline solutions appears to be facilitated by the quickness with which the galvanic fluid is absorbed by these saline solutions, and also by the diminution of the quantity of water in which the muriatic acid is diluted when formed. Salts which require but very little water for their solution, as muriate of lime, are peculiarly proper. Water acidulated with muriatic acid, exposed to the action of the galvanic fluid, by means of a gold wire attached to the positive pole of a strong pile, becomes oxygenized, grows yellow, and dissolves the gold.

Mr. Pacchiani was the first in Italy that obtained muriatic acid by galvanizing water with a gold wire; but as in his process the water is in contact with animal or vegetable substances, doubts might still be entertained that these substances contributed to the formation of the acid. To avoid this suspicion, Prof. B. galvanized water contained in a glass tube, by means of a very fine gold wire attached to the positive end of a pile. The communication was completed by a bent tube $\frac{1}{3}$ in. in diameter, filled with water, and of which the other leg was inverted into a second vessel of water; this second vessel communicated with the negative end of the pile, by means of a slip of cotton cloth, or of elastic gum, softened in warm water, or by a thin plate of tin. When a pile of 50 pair of discs was used, the galvanized water reddened tincture of litmus, but did not precipitate any metallic solutions so as to render the presence of muriatic acid sensible. But on using 100 pairs of metallic discs, 2 in. in diameter, and the tube containing the water being only 2 in. long, and of the diameter of a quill, the production of muriatic acid was manifested by its odour, by precipitating the nitrates of silver and of quicksilver of a white colour, and by the deep red colour it gave to the blue tinctures of vegetables. With the same apparatus, muriate of soda was obtained by galvanizing an exceedingly dilute solution of soda. When an iron wire was used in lieu of a gold one, muriate of iron was obtained; for the pure water which had by this means been galvanized for 16 hours, struck a blue colour with prussiate of potash, and a black colour with infusion of nut-galls.

Lime-water, galvanized by a gold wire, communicating with the positive pole of a very strong pile, was rapidly decomposed. When reduced to $\frac{2}{3}$, it smelt like muriatic acid, and slightly reddened tincture of mallows; potash decomposed the muriate of lime that it contained; but oxalic acid did not render it turbid,

so that we have another proof of the insufficiency of that acid as a test for lime, when the combination is acidulous.

The attraction of the metals for oxygen might be thought to favour the decomposition of water by galvanism; but the following experiment on the black oxide of manganese shews this is not the case. Pure water was galvanized by means of two pieces of this oxide, which is a good conductor, plunged into two parallel tubes, suspended by copper wire, so that the water could only act upon the oxide, one piece communicating with the positive end of a pile, and the other with the negative. At the end of 24 hours, the water in the tube communicating with the positive pole which alone has emitted much gas, contained muriatic acid, and precipitated silver of a deep reddish colour; the water in the other tube was strongly alkaline. Here two things are remarkable, that an oxide should produce muriatic acid, as well as gold, and that it should not be reduced by the nascent hydrogen.

When water is galvanized by means of two silver wires, the water being contained in two tubes, closed at bottom by a piece of bladder, and placed in another vessel, the water in the tube communicating with the positive pole, shewed decided alkaline characters: the same was the case when both wires were immersed in a single tube, a few lines from each other. Copper wires also, plunged into separate tubes, emitted much hydrogen from the negative wire, and the water was rendered alkaline in both tubes. The same effect was produced by metallic antimony. Ribands of tin plunged into separate tubes of water, emitted much hydrogen from the negative tube, no other alteration of the metal being produced than a slight blackish tinge: the water was strongly alkaline. No gas was emitted from the positive tube; the metal was corroded into a white oxide, which rendered the water milky, and then precipitated: at the end of six hours, the water in this tube was neither acidulous nor alkaline; at the end of twelve hours it turned tincture of mallows green. If the ribands were plunged into a single tube, the water was always alkaline and milky, from the oxide produced by the positive pole. Water in separate tubes being galvanized by zinc rolled into a riband, a rapid emission of gas and formation of alkali took place in the negative tube; from the other no gas was emitted, and at the end of 24 hours only some slight appearances of alkali were discoverable. The ribands were covered with a blackish crust.

Nitric acid of the specific gravity of 1.2 was galvanized by means of a gold wire attached to the positive pole of a pile; oxygen gas was emitted during the 12 hours that the experiment lasted; but there was no change observable in the acid, nor any solution of the gold. Davy has asserted the same, and Cruikshank, who used a platina wire; but Vassalli-Eandi asserts that

highly concentrated nitric acid may be decomposed by galvanism.

A solution of crystallized acetite of lead being galvanized, in the same manner, the gold wire soon became brown, and afterwards black in the upper part; lower down it had a deep red tinge, and at the end it became of an orange colour. No gas was emitted, and at the end of 26 hours the wire was covered with a black shining coat: this coat was a suroxide of lead; it came off in shining fragments, like black glass; it excited and conducted the galvanic fluid, it yielded oxygenized muriatic acid, and was soon changed into muriate of lead by the action of that acid: this muriate detonated by percussion with phosphorus.

Nitrate of silver being galvanized in the same manner, for 15 hours, did not yield any precipitate, although oxide of silver was formed.

The black oxide of quicksilver floated with water, being galvanized in the same manner, in a narrow tube, quite full, for two days, was changed into *oxide and hyperoxidized quicksilver*. The water slightly reddened vegetable blues, but did not contain any oxide or muriate of quicksilver.

Nitrate of quicksilver made without heat being galvanized, the gold wire was covered with small, dendritic, yellowish, insoluble crystals. This salt was not a mere oxide of quicksilver, *it was* (for then it would have been) opake, very white, and not crystallizable, nor was it a nitrate of that metal soluble in water; it turned black with lime-water, and had all the characters of sweet mercury, or *hyperoxidized* muriate of quicksilver.

Cruikshank and others have thought that nitric acid was formed by galvanizing water, because silver, quicksilver, and copper were acted upon by the fluid obtained. Silver galvanized in pure water is corroded into a grayish substance, and no nitrate of that metal can be obtained. Cruikshank imagines the insolubility of this product is owing to a surcharge of oxide. Potash added to the water did not produce any nitrate of potash. Some newly-prepared gray precipitate was galvanized under water for a whole day, by a gold wire communicating to the positive pole of a strong pile. The precipitate was not dissolved, nor did the water take up any of it.

The position of the silver (gold) wires may be varied, according as we desire the action should proceed from the positive or the negative end of the pile.

The alkali which has been found by chemists in water galvanized negatively has been supposed to be ammonia, and to be formed by the hydrogen arising from the decomposed water united with the azote of the common air absorbed by the water. Water which has been negatively galvanized, immediately turns

the tincture of mallows green, and tinges the solution of silver. It sometimes precipitates lime-water, and effervesces with muriatic acid. It is, however, so weakly alkaline, as not to have any taste.

Water, which contained black oxide of quicksilver diffused through it, being galvanized negatively by a gold wire, for 24 hours, the oxide was reduced and entirely covered the wire. The water, although alkaline, had no action upon the oxide, although ammonia, though much diluted, constantly combined with the oxide of quicksilver.

Two pounds of water which had been galvanized negatively being evaporated to a small quantity, shewed signs of containing a fixed alkali; muriatic acid was added to this residuum, and by gentle evaporation, crystals of muriate of soda were formed. Similar experiments were made, and constantly with the same success. It might be suspected that the soda came from the muriate of soda with which the cloth in the pile was soaked, as it is known that the soda is disengaged, and effloresces upon the pile; and that the cloth is reduced into soap of wool. When the pile was made of metallic discs, with pasteboard soaked in water, the galvanic effect did not appear sufficiently strong, but on soaking the pasteboard in sulphate of magnesia, the decomposition of the water was performed with ease, and on a sufficient quantity being galvanized negatively, it was still found to contain soda.

Water contained in a tube being galvanized by two gold wires, one communicating with the positive and the other with the negative end of the pile, for two days, was considerably diminished, but not in the least changed. On plunging the wires into separate tubes of water, connected as before stated, the water in the one was found to be rendered acid, and that in the other alkaline; the two waters being then united and evaporated, yielded muriate of soda.

Wires of pure gold, plunged into distilled water, and employed in galvanizing it positively, became covered with a thin coating of a saffron colour. This coating was not formed upon wires of gold alloyed with copper, nor upon gold wires attached to the negative pole. A similar yellowish coating is formed upon platina wire. It appears to Prof. B. to be a commencement of combination with the oxygenized muriatic acid that is formed.

Two wires of gold being plunged into a tube of distilled water at about $\frac{1}{4}$ in. distance from each other; that communicating with the negative end of the pile was soon covered with a black substance, which, after some hours, became spongy; sometimes when powerful piles had lost much of their strength, this matter became arborescent, or appeared like needles implanted one upon another. This black substance appears to be a hydrogenized hydrate of gold; it is inodorous and insipid; it blackens paper,

and the skin of the hands, which afterwards turn purple. A gold wire communicating with the negative pole, at the same time that the positive pole is connected with the water by a moist slip of paper, disengaged much hydrogen, but did not become covered with the hydrogenized hydrate of gold. The fluid was rendered alkaline. The hydrate is not soluble in a solution of soda, for, upon using this solution instead of pure water, with two gold wires, both of them were covered with the black crust, but it was very thin.

If after the black crust is formed (in the experiment with two gold wires, and pure water in a single tube) upon the negative wire, the wires are shifted from one pole to the other, in a few minutes the black crust disappears, and the gold re-assumes its brilliancy, while the other wire becomes black in its turn. The shifting of the wires may be repeated alternately with the same effect.

Wires completely covered with the hydrogenized hydrate of gold, and connected with a pile, conduct the galvanic fluid, and decompose water. A frog prepared in Galvani's manner, may be made to leap, by placing one end of the coated wire under the thighs, and moving the other end to the moist paper upon which the spinal marrow is placed. As this action may be produced by the slightest hydrogenizement of the gold wire, it is probable that the charge, or polarity observed by Ritter, in respect to louises-d'or, is owing to this circumstance. Prof. B. has observed analogous phenomena with silver, copper, and other metals, particularly antimony.

Two thick silver wires were introduced into a single tube of water; they were connected with the two ends of a strong pile, for twelve hours. Much gas was emitted from the negative wire, but very little from the positive, and an abundant sediment fell to the bottom of the tube. The negative wire was also coated with a dark gray spongy substance; the coating on the positive wire was black, less in quantity, and adhered to the metal. The coating of the negative wire was collected upon a paper; it became of a lighter colour, by being dried in the air, and, on being rubbed with a burnisher, it was found to be pure silver. It was, therefore, a hydrate of metallic silver. The coating of the positive wire was found to be hydrogenized silver; it blackened paper, linen, and the hands; it was slightly soluble in ammonia, insoluble in muriatic acid; it was not reduced by solar light, but it yielded to the action of hydrogen. A very small quantity only of this black crust, merely in form of a ring round the end of the wire, was formed when the wires were placed in separate tubes.

Two copper wires were placed in separate tubes of water, and connected with a pile: the negative wire, after some hours, became covered with a black crust, that was easily separated by a

piece of paper, which it rendered black; the copper then appeared more brilliant than before. When both the wires were plunged into a single tube, gas was disengaged from both wires; the black substance upon the negative wire had an arborescent form, but different in position from that formerly mentioned as being formed upon gold wires, which appeared to grow with the branches downward. This black substance was hydrogenized copper; it was insipid, insoluble in water and ammonia, and formed, without effervescence, a colourless solution in nitric acid: the absence of the blue colour, which is the usual sign of copper, was probably owing to the copper being in too small proportion.

A copper wire connected with the positive end of a pile, and placed in a separate tube, yielded oxide of copper; this soon changed into a greenish hydrate of oxide of copper, which became brown when dried by heat. The wire was covered with a steel-coloured crust, which left a grayish trace on paper; the copper itself was left slightly brilliant, and of a colour somewhat different from that of the negative wire.

Two copper wires, less pure, were galvanized for twelve hours in separate tubes; a whitish cloud descended from the positive wire, and passed through the double membrane which closed the bottom of the tube. It was converted in the water of the containing vessel into a hydrate of oxide of copper, in form of a greenish flaky substance. The negative wire produced only a small quantity of black hydrogenized copper. The water of the two tubes and that of the containing vessel was alkaline.

Two polished iron wires placed in separate tubes of water, were galvanized for 16 hours; a muriate of oxidulated iron, with excess of oxide, was formed in the positive tube, the water of which did not redden tincture of mallows, but yielded with prussiate of potash a white precipitate, that changed to blue in a short time. No crust was formed upon the (negative?) wire, it was merely rendered a little black; the water in the tube was strongly alkaline.

On repeating this experiment with wires $\frac{1}{4}$ of a line in diameter, and using a strong pile for 20 hours, a quantity of oxide of iron passed through the double membrane which closed the bottom of the tubes, and a copious precipitation of a gold-coloured hydrate of oxide of iron took place in the containing vessel. A part of this hydrate, in contact with the membranes, was decomposed, and changed into a deep black; the water in the containing vessel was neither acid nor alkaline.

Two iron wires plunged in a single vessel of water, yielded only a very small quantity of gas from the positive wire, but a large quantity from the negative wire; the water became of a yellow colour; it did not form Prussian blue by prussiate of potash, and was scarcely able to turn tincture of mallows green.

There also fell down from the positive wire a quantity of oxide, which immediately changed into a hydrate of oxide of iron. It was yellowish, flocculent, insipid, and insoluble in water; by drying upon blotting-paper it changed to an orange colour; a slight heat drove off the water, and a dark brown oxide of iron was left.

Two pieces of well-burned charcoal had iron wire inserted into one end, and were plunged about half their length into separate tubes of water, as in the former experiments. A great quantity of gas was disengaged from the piece connected with the positive pole, and a very small quantity from the negative piece. At the end of 24 hours, the water in the negative tube was found to be impregnated with carbonate of soda, but that in the positive tube shewed only very slight traces of that salt. The charcoal connected with the positive end, preserved its black colour; the other piece was sensibly whitened, by combining with the disengaged hydrogen.

Prof. B. thinks, that the inflammable gas which is sometimes obtained from charcoal by distillation, either arises from some humidity which has been attracted by the charcoal, or that it is the gaseous oxide of carbone. He also thinks, that charcoal when hydrogenized by galvanization in contact in water loses its conducting power; and that a vegetable pile might thus be formed of discs of pure charcoal coupled with those of hydrogenized charcoal, by interposing moistened pasteboard between each pair.

Hydrogen combines with metals as we have seen, and the metallic oxides are reduced by the galvanic action of the negative pole. Oxide of manganese, however, neither causes the disengagement of any gas, nor is it reduced, or rendered white, but it is hydrogenized. The oxide of manganese also speedily becomes a positive electromotor, in respect to the ungalvanized oxide.

Prof. B. in the course of a number of experiments made to determine the effect of the contact of metals and water, without the action of the galvanic pile, has never observed the production of an acid.

Iron was left in a matras with twice as much water, until the water was reduced to $\frac{2}{3}$; hydrogen was disengaged, and the metal was changed to an oxide; but the water that remained was not sensibly altered. Zinc had, in another experiment, the same effect.

Two oz. of distilled water were poured upon 5 oz. of zinc filings, in an 8 oz. phial, which was then hermetically sealed, and continually agitated. At the end of a quarter of an hour, the water was turbid; and by rest, deposited a brown powder. On continuing the agitation for about five hours, this brown powder was much increased in quantity. The water, on being decanted, had a peculiar smell, and a faint taste; it also rendered the tincture of

mallows green, and slightly affected the solutions of silver and of quicksilver.

Filings of copper, and of iron, also cause water to acquire the property of rendering tincture of mallows green. Quicksilver has the same effect. Although Priestley observed that this metallic substance caused water agitated with it to acquire a peculiar smell and taste, he did not discover the alkaline nature of the liquid.

The pulverulent substance obtained in these experiments, is metallic oxide extremely divided; that of zinc is grayish, those of quicksilver and iron are black, and that of copper brown. As the air in the matras is not altered, it is evident that the metal combines with the oxygen of the water, and that there is no sensible quantity of hydrogen disengaged.

The water alkalized in these experiments, being left upon the metals, loses its alkaline qualities, and enters into a new combination.

In order to determine the nature of the alkali, a small quantity of muriatic acid was added to water alkalized by zinc, or by quicksilver; the water was then filtered and evaporated to dryness, a salt was obtained in form of needles confusedly heaped together, but the quantity was too small to ascertain its nature with accuracy. It certainly was not muriate of soda; but Prof. B. thinks it was muriate of ammonia.

Before any consequences can properly be deduced from these facts, a number of researches must, Prof. B. remarks, be made, viz.

1°. The nature of the gas which is disengaged from water, galvanized positively by metals, must be determined; as also that of the gas which is yielded together with an alkali by charcoal.

2°. Whether the alkali formed in water galvanized positively by metals is of the same kind with that formed in water by the negative pole, namely soda?

3°. Whether water is necessary to the production of soda by galvanism?

4°. What are the constituent ingredients of this alkali?

5°. Whether the carbonic acid formed along with soda, by galvanizing water with charcoal, comes entirely from the charcoal?

6°. Whether the galvanic fluid, which is very active, and is probably composed of several very subtile fluids, does not furnish some of the ingredients of which the substances evolved during its action are composed?

7°. Whether the same products can be obtained if the water is galvanized when the atmospheric air is excluded, or when in contact with other gases?

8°. Whether water is really decomposed by being galvanized by metals, charcoal, and oxide of manganese?

9°. Whether the gas which is emitted by water during the

oxygenizement and hydrogenizement of metals by galvanism, arises only from the decomposition of the water?

10°. Whether the caloric which produces the aeriform state of the gases disengaged, comes from the water, or from the galvanic fluid?

11°. Whether the phenomena observed in galvanic experiments may be considered as similar to the effects of currents of electricity produced by electric machines?

12°. Whether the alkali formed in water by the contact of a single metal is produced by the galvanic fluid? And why is this alkali ammonia rather than soda? Why also cannot this alkali be obtained by a strong agitation in water which does not contain a sensible quantity of azote?

13°. Why do gold, platina, iron, and the black oxide of manganese, form muriatic acid by the galvanic action, and thus have different effects from other metals?

14°. If the metals and metallic oxides which produce muriatic acid by galvanic action, always yield oxygen (except iron, which becomes oxidized), why is not the muriatic acid produced by those metals which, like iron, become oxidized when galvanized positively? Why also is not the muriatic acid produced by iron or zinc by long continued immersion in water, especially since they disoxidize the water, even in the cold, and become oxidized themselves without the use of the galvanic pile? And why is an alkali formed in the latter case?

Prof. B. promises another memoir, in which he means to consider some of these queries.

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*Observation.*—These experiments confirm the opinion which we expressed in our last number, p. 84, relative to the necessity of an interruption of conducting power being made in these processes, in order to obtain the muriatic acid. The difficulties raised by these experiments are very great, and the subject requires the attention of every chemist.

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*On the Alum Ore of Tolfa. By Mr.* Gay-Lussac.—*Ann. de Chim.* No. 165.

To extract alum from this singular substance, it is only necessary to calcine it, and leave it exposed to the air about two months, taking care to sprinkle it with water several times a day; at the end of the second day the alum begins to be disengaged. The calcined ore changes into a paste, which is lixiviated with the smallest possible quantity of warm water. The lixivium yields very fine alum. The mother water would also furnish good alum, but it is thought preferable to employ it to elixiviate fresh ore. The oxide of iron which is present in the ore, is so much oxidized that it is not taken up.

The ore, according to Vauquelin, contains silica; it does not dissolve even partially in boiling water; and dilute sulphuric acid has scarcely any action on it. Nevertheless, on calcination it yields watery vapours, and sulphurous acid gas, and becomes very friable and porous. If immediately elixiviated, it yields a little alum; but if moistened, or even kept under water for some time, it swells, splits, and yields alum in abundance. No alteration is produced in the air in which this process is carried on.

Treated with potash, it did not exhibit any indications of sulphur or of sulphuretted hydrogen gas: but the liquor, after being saturated, precipitated the solutions of lead and of barytes.

Hence it appears that this ore is composed of a considerable quantity of sulphuric acid, united both with silica and with alumine; that the calcination expels the water, and breaks the union of the alum with the silica, so that the former becomes soluble in water.

The exposure of the calcined ore to the air for so long a time is not of course necessary for the formation of the alum, but merely for the breaking down of the ore; in the same manner as lime is better slaked by a small quantity of water than by a greater.

To investigate the cause of the sulphureous vapours, Messrs. Gay-Lussac and Humboldt made the following experiments: the crude ore was distilled; it yielded first a little inflammable gas burning with a blue flame, then a great quantity of sulphurous acid gas mixed with oxygen, and a little sulphuric acid. Those parts of the residuum which had been most exposed to the heat were insipid, but those in the centre had a very strong taste.

Fresh calcined ore yielded a little sulphuric acid, and a great deal of sulphurous acid gas, and of oxygen.

The best Roman alum, previously deprived of its water of crystallization, yielded a considerable quantity of oxygen, and of sulphurous acid gas mixed with a little sulphuric acid. The outward parts of the residuum were insipid; those in the centre still preserved the taste of the alum.

These experiments not only shew that sulphuric acid is present in the alum ore of Tolfa, but also that alum is decomposed by heat, and that its acid is separated into sulphurous acid and oxygen. This process may be used to obtain oxygen; as after it has been washed with a weak solution of alkali, the gas will be even purer than that obtained from nitrate of potash.

This decomposition is analogous to that of nitre. The requisite temperature is below that required for the vivid combustion of sulphur to form sulphuric acid. One of the two principles must of necessity be disengaged before the other, but it is not possible to say which, as they have always been obtained together.

The sulphureous smell, therefore, arises from the decomposition of the alum in the ore; and we may of course conclude, that this odour will be more powerful in proportion as the alum is dis-

engaged. At present the ore is calcined in lumps as big as a man's fist; hence some alum must be decomposed; as these lumps cannot receive an equal degree of heat in every part. The calcination can only be made in the night, because the finishing of it is indicated by a quivering motion observable on the surface of the stone, and by the colour being changed. If the calcination is too slight, the ore does not furnish alum; and if it has been continued too long, too much of the salt is decomposed. Some decomposition however of alum always takes place; as appears by the sulphureous smell, the alumine left in the residuum of the elixiviation, and the cubic alum deposited by the mother water. It is also said, that if even the aluminous solution is boiled too much, it deposits alum saturated with its earth. Messrs. Gay-Lussac and Humboldt did not however find much alumine in the residuum, and many useful improvements have lately been made, so that they will in future contain less. It is probable however, that by improving the construction of the furnace in which the ore is calcined, and reducing the ore to smaller fragments before calcination, still greater improvements may be made.

It would be proper to inquire whether alum could be changed into a sulphite, in the same manner as the nitrates are changed into nitrites by fire, and also, whether the other sulphates not susceptible of perfect neutralization, as those of glucine, &c. undergo an analogous decomposition.

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*Observation.*—Mineralogists have been divided in their opinions as to the arrangement of the alum ore of Tolfa: this paper shews it to be a sulphate of silica and alumine; and thus determines its proper place to be among the acidiferous minerals.

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*On the Decomposition of the Sulphuret of Barytes by Oxide of Manganese. By* C. F. Bucholz.—*Allgem. Jour. der Chim.*

From several experiments made with a view to determine whether the oxide of manganese would separate sulphur from barytes, as announced by Dize, the author draws the following conclusions:

The solution of sulphuretted barytes deposits its sulphur, by agitation with oxide of manganese. At the ordinary temperature of the atmosphere, there are formed by this process sulphite of barytes, and sulphuretted oxidule of manganese; by heating the mixture, only sulphite of barytes is produced, and the oxide of manganese becomes less oxygenized. The residues obtained in these processes undergo certain changes by heating them: the manganese in the residue formed without heat becomes less oxygenized, and forms a more intimate union with the sulphur;

on the other hand, the sulphurous acid in the residue formed by the assistance of heat is converted into sulphuric acid, and perhaps one part of it is volatilized.

These processes cannot be used for obtaining pure barytes, because there is always more or less sulphite of barytes produced, which renders it impure. A solution of sulphuretted barytes was exposed to air charged with carbonic acid gas; the precipitate thus obtained was also found on trial to contain, besides carbonic acid, a considerable quantity of sulphurous acid, agreeable to the observation of Berthollet, that by the decomposition of the alkaline sulphurets by the air, sulphurous acid is formed, instead of the sulphuric.

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*Observations.*—It could scarcely be expected, we think, that the barytes thus obtained would be free from the sulphite of that earth, since the difference of the attractions which come in play, is not sufficiently marked to produce a perfect decomposition.

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*Analysis of the Air of an Oil Cistern. By* REYNARD and FACQUEZ.—*Ann. de Chim.* No. 166.

A SOAP-MAKER'S man, at Amiens, descending into a cistern (which had not been opened for two years, and contained a small quantity of very thick, viscous, and rancid oil), fell down dead. Another man who attempted to go down in order to fetch him up, was obliged to return; his master succeeded him, and fell a victim to his courage. Five hours afterwards another man, sprinkled with vinegar, and breathing through a handkerchief wetted with it, attempted to bring up the two unfortunate persons who had been killed.

This cistern was a cube of about 12 feet each way, and had only a small horizontal trap door, so that the air had scarcely any communication with the atmosphere: on analysing the air of it, it was found that the air taken 2 feet below the opening, contained 86. of azote, 8 of oxygen, and 6 of carbonic acid gas. That taken at 1 foot from the bottom contained 80 of azote, 6 of oxygen, and 14 of carbonic acid.

On account of azote being the principal cause of the deleterious effects, no chemical agent could remedy them; and, of course, mechanical operations, either blowing or ventilation, were the only means to renovate the air of the cistern.

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*Observations.*—This analysis brings us acquainted with a new variety of what would be called choak damp (the usual kind of which is the carbonic acid gas of the modern chemists; the present is their azote), and can only exist in places which do not communicate with the open air. It is probable that the cases

which are related by Boyle, of the accidents that have occurred on opening boxes containing orpiment and other colours, have arisen from the absorption of the oxygen, so that the residual azote produced the accidents, rather than the exhalations of the colours, as was erroneously supposed by him.

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*Analysis of the Pearlstone of Cinapécuaro, brought from Mexico by Humboldt. By* Vauquelin.—*Ann. de Chim.* No. 165.

The specific gravity of this stone is 2.254. It agglutinated (probably by heat), and lost 4 per cent. By the blowpipe, it puffs up like icolite (perhaps zeolite), and becomes white, but is difficultly melted. It scratches glass. It is very friable, and easily reduced to powder. Fused with pure potash it first became yellow, but when in perfect fusion it changed to a green colour. On analysis it was found to consist of 77 parts of silica, 13 of alumine, 3 of iron and manganese, 1.5 of lime, 2 of potash, 0.7 of soda, and 4 of water. So that it is remarkable as being the first stone in which soda and potash united together have been discovered.

*Observation.*—The stone here treated of, is the lave vitreuse perlée of Hauy, and probably the same with the perlstein of Werner. But the latter is said to be soft, and even inclining to very soft.

In its analysis it nearly agrees with the pearlstone of Hungary, as determined by Klaproth.

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*Observations on the Alloy of metallic Antimony and Tin. By* M. Thenard.—*Ann. de Chim.* No. 165, *tome* 55.

An alloy which it was wished to introduce into use, in France, being much puffed on account of its resemblance to silver, its being very malleable, but especially for its inalterability by the air; M. Thenard examined it, by nitric acid, which converted it into a white oxide, but did not retain any thing in solution. The white oxide being dissolved in muriatic acid, was entirely precipitated by water. This singular effect, which, taken by itself, would indicate that the mass was merely metallic antimony, led the author to try similar experiments upon alloys of tin and metallic antimony, made for that purpose: some of these he found to be perfectly similar in their properties. Four parts of tin and 1 of metallic antimony were very ductile; even with equal parts of the metals the alloy still possessed some ductility, but by a very small addition of lead they became completely brittle. If the alloy contained more than $\frac{1}{3}$ of antimony, the solution in the

nitro-muriatic acid was not precipitated by water. M. Thenard tried several methods to separate the tin and antimony from each other, but with little success. Muriatic acid scarcely acted on the alloy, and even took up some antimony. Sulphuretted hydrogen, which precipitates the muriate of antimony, being made use of, did not make an exact separation. The volatilization of the antimony by heat, was equally unsuccessful. Treatment of the alloy with nitro-muriatic acid, so that the oxides might be oxidized to the maximum, and subsequent distillation, was more successful. The muriate of highly oxidized antimony remained in the retort, and so little passed over, that the distilled muriate of tin scarcely formed any precipitate with water.

From this difficulty of separating tin from antimony, M. Thenard doubts whether these metals may not have been found combined together, although the methods hitherto used have been insufficient for pointing out this alloy, if it occurred.

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*On the Use of Danais in Dying. By Mr.* A. Du Petit-Thouars.—*Bull. des Scien. Therm.* xii.

The danais of Commerson is a shrub, belonging to the natural order of stellatæ (or rubiaceæ), which grows in Madagascar. When the root of it is infused in arrack it produces a yellow tincture, and is changed itself to an intense and fixed red. The arrack being evaporated leaves a yellow powder, which, when mixed with gum arabic, spreads easily upon paper; this extract is bitter like quinquina. The root also colours the water in which it is boiled yellow, the root itself becoming of a fine red. Boiled with alum it gives a mixed colour of yellow and red. The inhabitants of Madagascar boil it with wood ashes to obtain a pure red.

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*On calcareous Carbonates. By Prof.* Proust.—*Journ. de Phys. Mars,* 1806.

Hauy was uncertain whether there was any difference between the aragonite and the calcareous spar. Mr. P. has found only lime in the aragonite, for the small quantity of iron which is obtained comes, he thinks, from the ochre which renders the crystals impure: but in all rhomboidal spars, whether transparent or opake, he has found two metallic carbonates ad minimum, viz. of iron and of manganese. This is a further proof of the similarity between the rhomboidal spars, and the white ore of iron, as well as the pearl spar, which also contains these metallic carbonates.

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*Observations.*—We consider this notice from Mr. P. as of great importance, since it does away what has always been es-

teemed the only stumbling-block in Hauy's system of crystallography. At the same time it tends to shew the necessity of attending, in all analyses, to the proper distinction of those principles which are really component parts of the body analysed, from those which are only accidentally united with it.

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*On a pneumatic Tinder-box. By Mr.* DUMOTIEZ.—*Journ. de Phys. Feb.* 1806.

IT having been discovered that prepared agaric (amadou) took fire by the compression of the air upon it, Mr. D. tried how far the size of the condensing syringe might be diminished. He has found that prepared agaric may be made to take fire in a condensing syringe $\frac{1}{3}$ in. in diameter, and 6 in. long, by a single stroke of the piston. He therefore recommends this method of procuring fire, as being without any danger.

*Observations.*—We do not perceive any great advantage in this method over the ordinary modes, by the collision of steel against any siliceous stone of sufficient hardness. The advantages of prepared agaric over tinder are well known, and it deserves to be more generally adopted.

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*On the fluoric Acid of fossil Bones. By Prof.* PROUST.—*Journ. de Phys. Mars,* 1806.

IN digging the foundations for a bridge across the river Manzaneres in Spain, they have found fossil ivory, and elephant's bones. Mr. P. obtained from them, by means of sal ammoniac, 14 or 15 per cent. of carbonate of lime; the remainder was soluble in muriatic acid, except 2 per cent. of charcoal, which burnt without yielding any smell: the muriatic solution contained a mixture of fluate and phosphate. On moistening the ivory with sulphuric acid, and exposing the mixture to heat, it emitted fluoric acid, as appeared by its corroding glass.

Fluoric acid is also found in some fossil grinders of the elephant, found in Peru, and in the fossil bones and teeth found at Terreul in Aragon; but Mr. P. could not perceive it in a fossil horn of the narwhale.

It appears that the fluoric and phosphoric acids are frequently united in the mineral kingdom. The English fluor spar contains both acids; but two Spanish varieties, one from Caranza in Biscay, the other from Xaca in Aragon, do not contain phosphoric acid: these varieties are not phosphorescent.

*On the Analysis of Jade.* *By* T. DE SAUSSURE.—*Journ. de Phys. Mars*, 1806.

IT is proper to make distinct species of the oriental jade, and that found in Switzerland, which Delametherie had denominated l'hemanite, but which Mr. S. prefers to call, in honour of his father, saussurite.

One hundred parts of deep green saussurite yielded 44 silica, 30 alumine, 4 lime, 12.5 oxide of iron, 0.05 oxide of manganese, 6 pure soda, 0.25 pure potash, and 3.2 were lost.

One hundred parts of oriental jade, which had been worked into an amulet, yielded 53.75 silica, 12.75 lime, 1.5 alumina, 5 oxide of iron, 2 oxide of manganese, 10.75 pure soda, 8.5 pure potash, 2.25 water, and 13.5 were lost.

*Observation.*—Neither of these analyses agree as to the sum of the ingredients being equal to the original quantity, but we cannot tell where the error lies.

*On the distilled Waters of inodorous Plants.* *By* DEYEUX.—*Ann. de Chim.* No. 168.

THE author distilled separately 25 inodorous plants with water, and cohobated the water upon fresh plants. He found that in general three distillations were sufficient to saturate the water. All these waters had a particular taste, and the odour of the plants from whence they were drawn; but this odour was very strong. Some were rather thick, but most of them were perfectly transparent. It was remarkable that most of these waters affected the nostrils very powerfully, as if they had been drawn from scurvy-grass, or the roots of horse-radish. It is sufficient to mention the water drawn from the lesser centaury, a plant which has scarcely any smell, but that of its water could hardly be supported. On the third distillation there appeared a little thick and whitish oil, having a very sharp and biting taste.

The waters thus prepared do not all keep equally well. Some speedily alter, as water drawn from borage. These waters spoiled much sooner in vessels of white glass exposed to the light; and on separating the sediment formed in borage water, the putrid odour it had contracted left it, and it resumed its proper smell. It is also necessary, in order to preserve these waters, to abstain from keeping them in vessels perfectly close.

It has commonly been supposed that water distilled from inodorous plants does not take up any effective principles; but independently of an instance of the sedative effect of lettuce-water, Mr. Despres, an apothecary at Paris, informed the author, that the gauze manufacturers in his neighbourhood used the distilled water

of argentine (pentaphylloides argenteum alatum, seu potentilla, silver weed or wild tansey), to soak their gauzes in, as the only means to give them the requisite lustre and stiffness. And this was not a mere routine of business; for his assistants having, unknown to the manufacturers, substituted distilled common water for it, the manufacturers came to complain of its inefficacy.

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*On Guano, a Manure found in the small Islands in the South Sea, near the Coast of Peru. By* FOURCROY *and* VAUQUELIN.—*Ann. de Chim.* No. 168.

WE learn from Humboldt that guano is a substance which is very abundant in the islands of the South Sea, particularly in the isles de Chinche near Pisco. The inhabitants of Chancay fetch it from those islands in vessels that carry from 1500 to 2000 cubic feet of it; the voyage out and in takes 20 days. It is sold at Chancay at the rate of 14 livres (12*s.*) the vanega ($1\frac{1}{2}$ bushel); at Africa it fetches 15 livres.

The beds of guano are from 50 to 60 feet thick. On the same islands are found abundance of birds, but their excrements have only formed in 3 centuries beds of 4 or 5 lines in thickness. The fertility of the coasts of Peru is entirely owing to this substance, the cargoes of which may be smelt at the distance of $\frac{1}{4}$ league, and cause, on approaching them, continual sneezing, although the sailors on board are from habit not affected in this manner. The use of this manure was adopted from the native Indians.

On examination by Fourcroy and Vauquelin, guano was found to have a dead yellow colour, no taste, but a very strong smell partaking of the odour of castor and valerian: it becomes black in the fire, yielding a white smoke, and the smell of ammonia. Its solution in water reddens tincture of litmus. By a series of ingenious experiments, the component parts of it were found to be uric acid, which forms $\frac{1}{4}$ of the mass, and is partly combined with ammonia and lime; oxalic acid, also partly combined with ammonia and potash; phosphoric acid combined with ammonia, potash, and lime; the muriates of ammonia and of potash in small quantity; a little fatty substance; and some sand partly siliceous and partly ferruginous: so that this substance appears to be similar in its nature to the dung of water-fowls.

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ERRATA.

Page 139, line 29, *for* depend, *read*, depends.
141, — 12, *for* denomination, *read*, denominator.
14, *for* denominator, *read*, numerator.
152, — 22, *for* wall, *read*, window.

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# RETROSPECT

OF

# PHILOSOPHICAL, MECHANICAL, CHEMICAL AND AGRICULTURAL DISCOVERIES.

No. VI.] *July, August, September.* [1806.

## NATURAL PHILOSOPHY, ARTS, AND MANUFACTURES.

*Account of Experiments of the Effects of Compression in modifying the Action of Heat made by Sir* JAMES HALL, *Bart.* F.R.S.S. —*Trans. Royal Society Edin. Vol. vi. Part* 1.

THE principal object of Sir James Hall in these experiments was to ascertain the possibility of the formation of certain mineral substances by the action of heat, which the opposers of the Huttonian system of geology supposed to be produced in a different manner. Sir J. Hall states, that at first he was averse to this system, but was afterwards convinced of its truth by Dr. Hutton, by whom he was prevented from putting the matter to the test of experiment, as the Doctor did not think it possible to imitate by art the operations of Nature so exactly on this point as to produce a fair experiment. After the Doctor's death, Sir J. Hall thought himself at liberty to commence his desired investigation.

Carbonate of lime was chosen as the subject of the experiments; because the modifications of this substance were supposed by the anti-Huttonians to be most decidedly formed in a different manner: if then these substances could be produced by heat acting in an apparatus capable of preventing the escape of their gaseous part, it would at least decide the possibility of the large natural masses of them being formed in the same manner.

Sir J. Hall made a great number of experiments on this subject in a variety of apparatus, contrived with great ingenuity. He first used gun-barrels, welded at the muzzle after the carbonate of lime was introduced, covered to the extremity of the barrel with pounded baked clay.

He then used barrels closed by soldered stoppers: this method

was laid aside for the use of the fusible metal, which served in the place of the baked clay and of the stopper; the barrels were filled with this metal in fusion over the carbonate, and afterwards by immersing their muzzles in water: while their other extremities were exposed to the fire, a sufficiency of the metal was kept cool, to prevent the escape of the heated carbonic acid of the carbonate.

He also used porcelain tubes, which he at first closed by glass of borax and afterwards by a mixture of pounded bottle glass and pounded flint, which had a better effect: in these the glass was fused by heating their muzzles while their bottoms were kept cool: and then, on cooling the tubes, the glass acted as an effectual stopper.

Barrels of iron bored from the solid, and of considerable thickness, were also used.

To ascertain the force of the compression, an apparatus was contrived, by which a weight pressed a stopper of lead against the top of a gun-barrel; the weight was regulated by a lever and a counterweight to any desired force inferior to itself, which was found to be better than causing the lever to press on the stopper and using but a single weight, as the spring of the lever in the latter case was found to admit gas to escape before the force could be communicated to the resisting weight.

The substance to be examined was enclosed in small tubes of glass or porcelain, or wrapped up in thinly laminated platina, and placed in a little iron cage, or cradle, sufficiently small to enter a gun-barrel, and connected with an iron rod: into the same cage were also put a pyrometer piece of Wedgewood's preparation, and a small tube of iron or porcelain containing only air, which prevented the fusible metal from forcing the barrel by yielding a little to its pressure: a piece of chalk was also put into the cage, cut to a size fit to fill up any interval remaining. When an iron barrel was used, it was half filled with liquid fusible metal, and the cage plunged to the bottom of the liquid; the metal was then allowed to cool and fix round the cage and iron rod; after this the barrel being filled with the fusible metal, was ready for the application of heat to its breech.

The barrels were at first placed horizontally, with their lower extremities enclosed in a muffle fixed horizontally in a furnace for this purpose, and their muzzles were kept cool by wet cloths; but afterwards Sir J. Hall preferred to place them vertically in a perpendicular muffle surrounded with fire, while their muzzles were immersed in water contained in an iron tube placed beneath the furnace, with a pipe running from it beyond the furnace, by which the water might be renewed in proportion as it was evaporated by the heat. A chain was so fastened to the barrel, that by drawing it the barrel might be raised as required.

At the conclusion of each experiment the fusible metal was discharged by heating the barrel first at the muzzle, while it lay incli-

ned a little downwards, and afterwards the rest of it in succession; by which means the cage containing the carbonate was disengaged.

In an experiment performed in the described apparatus, pounded chalk was converted into hard dense marble, by a heat of 33° Wedgewood: in another experiment with chalk the same result took place at an heat of 23°; and a crystal more than a tenth of an inch square was found, on breaking the mass, which exhibited the rhomboidal fracture of calcareous spar.

When porcelain tubes were used, they were at first found to permit the passage of the gas through their pores; but this defect was prevented by glazing over their internal surfaces with borax in a thin state of fusion. With these tubes also pounded carbonate of lime was converted into stony masses nearly approaching sound limestone in hardness, compactness, and specific gravity; and some of the results by their semi-transparency, saline fracture, and susceptibility of polish, deserved the name of marble. The chalk in these experiments was found to shrink three times more than the pyrometer pieces in the same temperature, and acquired a great additional specific gravity.

A specimen of marble formed in this manner from pounded spar was so complete as to deceive the workman employed to polish it; and many specimens were obtained which retained their polish, after a lapse of four or five years, as well as any marble, though kept without any peculiar precaution.

Sir J. Hall found that porcelain tubes could not be used in a heat above 27°, without being destroyed either by explosion, the formation of a minute rent, or the swelling of the tube; and therefore resumed his experiments in iron tubes. The tubes of porcelain sometimes swelled to double their diameter, without bursting. He thinks, however, that in France and Germany experiments in such tubes might be tried to a greater extent, as porcelain is to be obtained in those countries of so much superior quality to what is made here.

A great variety of specimens of stony matter were produced in the iron tubes, for the formation of which the author accounts in a very satisfactory manner. By slow cooling more decisive crystallization of the matter was obtained, and an actual transparent crystal from pounded chalk was produced, which was more convincing than that obtained from solid chalk, as in the latter it might have previously existed in the mass.

In one of the experiments in the barrels bored from the solid, some of which consisted of tubes about three quarters of an inch diameter, in bars two and a half inches square, of that remarkably tough iron known by the name of *old sable*, crystals were formed by sublimation, of a substance which neither effervesced nor dissolved in acid, but was of too small a quantity to be further examined. In these strong tubes the complete fusibility of the carbonate under a strong pressure was ascertained, and experiments were performed in them in a heat as high as 79° Wedgewood. It was also proved

that when the carbonic gas was prevented from escaping, fusion could be performed in temperatures between 25° and 15°, which evinced that the carbonic acid acted as a flux, as quicklime by itself proved refractory in the great heat of 79°.

To increase the pressure, the author introduced small portions of water into the tubes, by adding it to a small piece of chalk or baked clay, which he then dropped into a tube of porcelain about an inch in depth and covered with pounded chalk, which was rammed firmly upon it. This tube was then placed in the cradle along with the subject of experiment, and the whole plunged into the fusible metal, previously poured into the barrel, and heated so as to render it merely liquid.

Various other volatile substances were tried to increase the compression, such as nitre, nitrate of ammonia, carbonate of ammonia, and gunpowder; but water was found to produce the best effect.

In one of the experiments a substance was formed from a fusion of chalk and silex, which resembled chalcedony, and which dropping down while in a viscid state, into a hollow accidentally existing in the mass, formed therein a stalactite and stalagmite evidently corresponding with each other. In another experiment, from a mixture of pounded oyster-shell, chalk, and a tenth of silex, a hard and firm matter was produced, with that irregular black colour interspersed through the mass, which is observable in the Alpine marbles, particularly in that kind called at Rome *Cipolline*. Those hard substances thus formed all effervesced with the mineral acids; and the last mentioned with nitric acid formed a solution that agglutinated into a transparent jelly breaking with sharp angles.

It having been suggested that the carbonate of lime might have been fused in the experiments from substances accidentally mixed with it, or from the matter of the tubes acting as a flux, trials were made with pure carbonate prepared artificially, with pure calcareous spar from St. Gothard (remarkably transparent, and having a double refraction), and with shell, carefully prevented from any communication with the tubes, by being wrapped up in thinly laminated platina; all of which substances were perfectly fused; but the pure carbonate was more refractory than chalk, and only formed a mass of the hardness of sandstone. It was observable in the experiment with the shell, that two pieces of it were welded together by the heat, and that the whole altered its shape but very little during the fusion.

In the experiments made to ascertain the degree of the pressure under which the carbonates were fused, in the apparatus wherein a great weight acted on a stopper to close the tubes; various weights were used from 3 cwt. to 10 cwt. in different temperatures from 21 to 51°; by which it was ascertained that with a pressure equivalent to 52 atmospheres or 1700 feet of sea-water, lime-stone may be formed with an adequate heat, from chalk or shell; that under a pressure of 86 atmospheres, or

3000 feet, about half a mile of sea, a complete marble may be formed; and lastly, that with a pressure of 173 atmospheres, or 5700 feet, or little more than a mile of sea, the carbonate of lime is made to undergo complete fusion, and to act powerfully on other earths.

In one of the experiments with the last-mentioned apparatus, the internal part of a piece of leather, put between the stopper and the tube, having been converted by the heat into a coal burning without flame, and which had evidently been in fusion, Sir J. Hall was induced to try experiments on this subject with other substances, and intends to continue them hereafter. In those experiments pit-coal was completely fused in a red heat, and still burned with flame, but in a great heat it lost this faculty, together with half its weight, and in this state resembled what is called *blind coal.* Fir saw-dust and horn were found to be much more volatile than coal, and could not bear so great heat, being subject to destroy the apparatus even in the lowest red heat. The horn was vastly the most fusible and volatile of the two; in a slight red heat it was converted into a yellow red substance, like oil, which penetrated the clay tubes through and through, in which it was confined; tubes of glass were afterwards used: it was only after a considerable portion of the substance had been separated from the mass that the remainder assumed the clear black peculiar to coal. In this way coal was obtained both from the horn and the saw-dust, which yielded a clear flame in burning. A mixture of the two produced a substance having exactly the smell of soot or coal-tar. In a pressure inferior to 80 atmospheres the horn was dissipated entirely, which is a curious circumstance, as it leaves a coal if burned in an open vessel. In some of the experiments where great care was taken to discharge the fusible metal out of the barrel, after the operation, with as little heat as possible, the horn acquired a semi-fluid and viscid consistency, with a yellow red colour, and very offensive smell; which shews that in the other experiments both its colouring and odorant matter had been driven off by the too great heat used after the pressure was removed.

The organization of animal matter was entirely obliterated by a slight action of heat, but a stronger heat was requisite to perform the entire fusion of vegetable matter.

The various substances mentioned by Mr. Hatchet as nearly allied to coal (in his publication on this subject), Sir J. Hall thinks may be accounted for, from the effects of various heats acting on organic substances under various degrees of pressure.

In the ninth section of his paper, Sir J. Hall applies the facts mentioned in the preceding part to geology according to the Huttonian system. He proves from various circumstances that volcanic fire is deeply seated, and that lava in a state of fusion may be raised so as to have a great depth in the crater, and exercise a proportional pressure, subject to the laws of hydrostatics, from being a

liquid. Hence this lava flowing on beds of chalk or of shell at a great distance below its surface, would unite the effects of heat and compression before related, and convert these substances into lime-stone, marble, or other calcareous stones, according to various concomitant circumstances.

Whenever the liquid lava had a depth of 600 feet, it is proved that there would be a sufficient pressure for these purposes: cases might exist in which the calcareous matters would be so confined by beds of ponderous and impenetrable substances, that the carbonic acid might be prevented from escaping, and their fusion take place at much less depths: and an instance is given of Mount Saleve, where calcareous beds are found in this situation.

Ancient lavas stop up side-passages in craters through which fluid lava might escape, by which it will be forced to rise higher, and of course exercise a greater pressure on the substances beneath it: there have been instances of even the perpendicular vent being closed in this manner, which was the case in Vesuvius for near half a century: when, therefore, an eruption is sufficiently powerful to force such a barrier, a prodigious pressure must be exerted on the lower beds of fossils with a sufficient temperature to fuse them totally.

An instance is to be seen in a vertical section of Mount Vesuvius at the cliff of Somna, which is several hundred feet in height (and which is best viewed from the little valley called the *Atrio del Cavallo)*, of lava having been in the state mentioned, a fluid mass of a vast height; for several vertical veins of lava are here visible, traversing the alternate beds of scoriæ and lava from the top to the bottom.

In Mount Etna similar vertical veins no doubt exist, of much greater height, since this mountain occasionally delivers lava from its summit which rises to 954 feet above the level of the Mediterranean.

The combination of heat and pressure resulting from such circumstances the author thinks sufficient to account for the igneous formation of all rocks from loose marine deposits. The sand would thus be changed to sand-stone, the shell to lime-stone, and the animal and vegetable substances to coal.

Other beds consisting of a mixture of various substances would be still more affected by the same heat; those containing iron, carbonate of lime, and alkali, together with a mixture of various earths, would enter into their fusion, and penetrating through every crevice that occurred, would in some cases reach what was then the surface of the earth, and constitute lava; in other cases it would congeal in the internal vents, and form porphyry, basalt, green stone, or any other of the numerous substances we call *whin-stone*. Beds of less fusibility would enter into a state of viscidity, in which state bodies are still susceptible of crystalline arrangement, and being confined by beds of more refractory matter, would there crystallize, without changing their place, and thus form those beds of whin-stone which frequently occur interstratified with sand-stone and lime-stone.

Where the heat was more intense, the beds of primary schistus might be formed from strata of sand; and when the heat was still higher, the sand itself would be entirely melted, and be converted by slow cooling into granite, sienite, and other stones of this class.

To account for the appearance of beds of such substances at the surface, which could only be fused under great pressure, the author has recourse to Saussure's theory, which supposes that the superincumbent matters were forced off them by the effect of vast torrents (of depth sufficient to overtop our mountains), which have swept along the surface of the earth at remote periods.

Four quarto plates, extremely well executed, of the apparatus, and one of the volcanic sections, accompany this paper in the original, which consists of 114 pages. In order to extend the knowledge of the facts contained in it, the author has very liberally supplied some of the periodical publications with these plates free of expense.

A table of the specific gravities of the various stony matters produced by the experiments, is added in the appendix, in which the author has shewn those of porous substances, both when soaked with water, and when free from it, which occasions considerable difference, and on which subject he makes very just remarks.

In the appendix is also given the annexed table of the reduction of the forces of the various degrees of compression to a common standard, under which twelve different experiments were performed in the apparatus, in which the tubes were closed by stoppers pressed down by incumbent weights.

| Number of the Experiments. | Bore of Tubes in Decimals of an Inch. | Pressure in Hundred Weights | Temperatures by Wedgewood's Pyrometer. | Depth of Sea in Feet. | Depth in Miles. | Pressure expressed in Atmospheres. |
|---|---|---|---|---|---|---|
| 1 | 0.75 | 3 | 22 | 1708.05 | 0.3235 | 51.87 |
| 2 | 0.75 | 3 | 25 | 1708.05 | 0.3235 | 51.87 |
| 3 | 0.75 | 10 | 20 | 5693.52 | 1.0783 | 172.92 |
| 4 | 0.75 | 10 | 31 | 5693.52 | 1.0783 | 172.92 |
| 5 | 0.75 | 10 | 41 | 5693.52 | 1.0783 | 172.92 |
| 6 | 0.75 | 10 | 51 | 5693.52 | 1.0783 | 172.92 |
| 7 | 0.75 | 10 | — | 5693.52 | 1.0783 | 172.92 |
| 8 | 0.54 | 2 | — | 2196.57 | 0.4160 | 66.71 |
| 9 | 0.54 | 4 | — | 4393.14 | 0.8320 | 133.43 |
| | | 8.1 | — | 8896.12 | 1.6848 | 270.19 |
| 10 | 0.75 | 3 | — | 1708.05 | 0.3235 | 51.87 |
| 11 | 0.75 | 4 | — | 2277.41 | 0.4313 | 69.70 |
| 12 | 0.75 | 5 | — | 2846.76 | 0.5396 | 86.46 |

*On the Propagation of Electricity. By Dr.* Oersted.—*Jour. de Phys. May* 1806.

The object of the author of this fragment is to explain the internal propagation of electricity, and to shew its similarity to the propagation of magnetism, that of sound, and other well-known phenomena.

The Doctor endeavours to shew that this propagation is undulatory, and instances in the case of a globular electric body and a cylindric conductor, where the states known by the names of communication of electricity, and partition of electricity, take place of one another rapidly in successive cylindrical zones: Dr. Oersted calls these the first and second degrees of electrization; the former being a polarization, the latter an identification: they are supposed to succeed alternately, by propelling one another forward like waves, gradually augmenting in perimeter from a common centre. The progress is conceived to persist in this manner until the negative electricity extends itself over all the superior moiety of the cylinder, and the positive over the inferior part, while the middle remains indifferent.

In confirmation of this theory, several experiments are related. The electricity in good conductors runs over about a German mile (28,995 feet English) in a second: in this rapid course, it is impossible to trace the successive changes of the positive and negative electricity; but in bad conductors the thing is more appreciable. Take a stick of glass, or of resin, or of Spanish wax; bring it near to an electrized body, and on observing the result with an electrometer, the alternate zones of the contrary electricity will readily be found: the experiment is known to all philosophers.

If we attempt to melt a long iron wire with a feeble charge of the electric battery, we shall soon perceive that a part of it has been melted while the other is untouched, and that these parts succeed each other alternately. If a very strong charge be employed, all the wire will be dissolved, but it will be reduced into small globules, which are only the effect of different expansive and contractile zones. A charge may be so constituted that the metal shall be heated red without being melted: this wire will carry evident marks of the changes of the expansive and contractile zones.

These experiments are all well known to philosophers, and are the strongest proofs of the undulatory propagation of electricity. But if the charge of the battery be augmented to such a point that it may volatilize the iron, and if the experiment be so managed that the vapour may be projected in part on a sheet of

paper, then we shall have the complete image of the propagation of electricity in the waved tint on this paper, with the alternate changes of expansion and contraction. Even the thickness of the smoke, and its colour, change so regularly, that we may say we have a coloured portrait of the oscillatory expansion of electricity. The constancy of the phenomenon announces evidently enough that it is not imputable to accident. Let the experiment be made with any metal at pleasure, still we shall not find a single exception. But those who would be spared the pains of repeating these experiments have only to cast their eyes on the numerous and faithful images in which Van Marum has given the explication of this phenomenon. The regularity of this image may likewise be seen in another manner. If the electricity acted on the metallic wire solely with the expansive force, all the waves of the vapour would be parallel and rectilineal; but as each conductor acts with the repulsive force on the nearest extremity of the wire, the waves of the vapours will be propelled to the two extremities by two forces, which intersect perpendicularly according to the diagonal, or rather, as the forces are constant and unequal, the waves will represent the image of a curve line whose concavity is opposed to the metallic wire. The more a wave is distant from one of the conductors, the less will it be acted upon by the repulsive force parallel to the wire, and its position will approach nearer to the force perpendicular to the wire. In the middle of the wire there will be a perfect equilibrium between the contrary forces; consequently the position of the wave must be perfectly perpendicular to the wire.

If another proof be wished for, it will suffice to consider the electric spark. If the conductors in the midst of which the spark manifests itself are sufficiently near, it is remarked that it is coloured differently at the two extremities, viz. red at one and blue at the other, while the middle is white; but if the conductors are removed farther off, the spark will change its colour as often as there are changes from negative to positive.

All that has been hitherto said of electricity applies equally to magnetism. The action of the magnet commences by a polarization, and ought of consequence to be communicated by undulations, like electricity. A zone of polarity must arrive at its maximum of expansion, and then it must give the origin to another. This is confirmed by experiment, since when a very thin steel wire is magnetised, it acquires, throughout its length, north and south poles alternately.

This mechanism of the action of the undulatory propagation is doubtless general throughout nature, but it is very difficult to demonstrate. It has been observed, long ago, that in compressing a particle of air an expansion would ensue, in consequence of which the neighbouring moleculæ would be compressed, and then these expanding in their turn would compress others, and

so on. It is thus that the communication of sound in the air has been explained; but the same mechanism has not been well considered in the communication of sound through hard bodies.

At least the majority of philosophers oppose the discovery of the celebrated Chladni, of the trembling of the moleculæ in the production of sound. But nothing is more easy than to demonstrate, even by the nature of the thing and by experiment, the necessity of the existence of this tremulous motion. If one of the extremities of a steel wire be powdered over with *lycopodium*, and be afterwards struck with a blunt and moderate blow, we shall see the dust divided into little protuberances, which will figure a line along the wire; the protuberances formed near to the point struck will be the greatest, the others will be less considerable in proportion to their distance. The same thing may be demonstrated in a still more simple manner, by means of a small square tablet of glass with straight borders. Its surface must be powdered over with lycopodium, and the tablet so held as only to touch the two opposite sides with the fingers, leaving the other two sides at liberty. If we strike with a small piece of wood on the middle of one of the edges at liberty, the powder will be immediately divided in lines parallel to the direction of the stroke's inclination; and in these lines several elevations and depressions may be observed; but if the stroke were given with a rough plate, or some other flat body, and especially upon an entire side, the powder will arrange itself in lines parallel to the side struck. These lines will be more or less waving, according as the side struck has been more or less precisely affected on all its points. If it be struck on one of its surfaces, there will arise a number of little protuberances. These are doubtless the results of an oscillatory motion, or more precisely of a progressive motion and an undulatory one.

But when the tablet is held without touching the edges, by applying the fingers to a small portion of the two surfaces, and striking upon it, there will not merely be formed little protuberances, but a sound will be created. The protuberances will assume such a motion as will oblige them to re-unite at the extremity, and they will take very nearly the figure assigned them by Chladni. From this, and similar experiments, Dr. Oersted suspects that there is excited a kind of electricity by the undulatory motion, an electricity which is negative in the lines of the nodes and positive in those of the rest, since the lycopodium is attracted there negatively.

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*Observations.*—Although none of the experiments adduced in this paper can fairly be elevated to the rank of an *experimentum crucis*, yet, contemplated together, they give an air of probability to the theory Dr. Oersted has advanced; and this probability is strengthened by some obvious considerations. It is now admit-

ted on all hands that sound is propagated by an undulatory motion of the air, or of certain separate gases in which the sonorous body shall be immersed; and it is likewise known and admitted that the intensity of sound diminishes in proportion as the square of the distance from the sonorous body increases. Now Æpinus has proved that the electrical actions follow the inverse ratio of the square of the distance; and Coulumb has demonstrated that the same law obtains with regard to magnetical actions: in this respect, therefore, the propagation of sound, electricity, and magnetism conform to the same law. Again, it is allowed, by the best theorists, that the electric matter and the magnetic substance is each constituted of two particular fluids, sometimes combined, at others separable: and, if it could be shewn that these fluids are elastic, like the gases which constitute atmospheric air, the analogy, though not perfect, would be nearly as complete as could be wished. Moreover, in the language of modern chemistry, caloric possesses the properties of an elastic fluid, and likewise possesses the power of converting bodies first into liquids and then into elastic fluids, just as by means of certain processes all bodies are susceptible of acquiring the electric virtue: indeed there is a very close analogy between caloric and electric matter; for both of them tend to diffuse themselves equally, both of them are propagated by friction, both of them dilate bodies, both of them fuse metals, and both of them kindle combustible substances. Mr. Achard has proved that electricity can be substituted for caloric, even in those cases where its agency seems peculiarly necessary; for he found that by constantly supplying a certain quantity of the electric fluid, eggs could be hatched just as when they are kept at a temperature of 103° of Fahrenheit. So that, on the whole, it will not be reckoned very unreasonable if we conceive that the component fluids of electricity are really elastic; whether elasticity be granted to the magnetic fluids or not; and since the propagation of motion by undulations is a necessary consequence of elasticity, there will be tolerably strong grounds for inferring the probability of Dr. Oersted's theory: we mean with respect to electricity and magnetism; for we are by no means prepared to assent to this philosopher's affirmation that "the undulatory propagation is doubtless general *throughout nature*." Descartes and Euler have, it is true, contended for the undulatory propagation of the motion of *light*, for example; but that hypothesis is exposed to some insurmountable objections from which the Newtonian system of emanation is entirely free: on the undulatory hypothesis, where the light is not distributed in right lines, but its motion is transmitted in all directions like that of sound, the impression of luminous bodies would manifestly be carried behind opake obstacles, which in truth are now found to be insuperable; in that case, the body of the earth would only divert the progress of light in the same manner as a

large stone would divert the progress of a stream of water, the whole terrestrial globe would be enveloped in a flood of light, and we should have perpetual day. This being contrary to fact, the undulatory hypothesis must be abandoned as untenable; and indeed its fallacy is shewn directly, by many experiments of Dr. Herschel, Mr. Leslie, and others, on the connexion between radiant heat and light: so that, however inclined we may be to admit the probability of Dr. Oersted's hypothesis as it regards electricity and magnetism, we must, notwithstanding, be permitted to deny its universality in natural operations.

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*A geometrical Investigation of some curious and interesting Properties of the Circle, &c. By* James Glenie, *Esq. A.M. F.R.S. Lond. and Edin.—Edin. Trans. Vol.* vi. *Part* 1.

In this paper many of the curious theorems first published by that truly elegant and inventive geometer the late Dr. Matthew Stewart, the demonstrations of which he retained to himself, and a great variety of other theorems, are derived as so many corollaries, from the following general though simple proposition.

Let A, B, C, &c. be any number of points in the circumference of a circle, that number being denoted by $n$. Let RA, RS, ST, &c. be tangents to the circle in the points A, B, C, &c., and let POQ be any diameter. Then shall the sum of all the perpendiculars drawn from the extremities P and Q of that diameter, to the lines RA, RS, ST, &c. touching the circle in the points A, B, C, &c. be equal to $PQ \times n$, or be a multiple of the diameter by $n$.

Also, if from any two points $p$, $q$, in the diameter PQ, equally distant from the centre O, perpendiculars be drawn to the lines touching the circle in the points A, B, C, &c. their sum will be equal to a multiple of the diameter by $n$.

But, if from any two points V, W, in PQ produced, equally distant from the centre O, lines drawn perpendicular to any other diameter B $r$, passing through any point of contact B, fall beyond its extremities B, $r$, the *difference* of the perpendiculars drawn from W, V, to the line touching the circle in B, is equal to the diameter, and so on.

So also, when perpendiculars from the points V, W, in PQ produced, to the diameters passing through the points of contact A, B, C, &c. do not fall beyond the extremities of any of these diameters, perpendiculars from V and W to right lines touching the circle in the points A, B, C, &c. are, taken together, equal to a multiple of the diameter by the number of the said points.

And it flows as a corollary, that the sum of perpendiculars drawn from P, Q, or from $p$, $q$, to the sides of any regular figure circumscribed about the circle, is equal to twice the sum of per-

pendiculars drawn to the sides of a regular figure of the same number of sides circumscribing the circle, the perpendiculars being let fall from any point within the same regular figure.

From these and a few other general properties which Mr. Glenie demonstrates, and the corresponding figures to which any geometer may sketch from the preceding enunciations, this ingenious gentleman deduces several of Dr. Stewart's "general theorems," and shews that an unlimited number of other theorems, respecting figures both regular and irregular, circumscribing and inscribed in the circle, may easily be derived from the same investigation; as well as a great number of geometrical infinite series, with their summations. And as to theorems respecting given points, right lines and figures, either regular or irregular, given by position, and right lines intersecting each other in one point or in different points, in angles either equal or unequal, that are deducible from it, they are in a manner innumerable. Several are selected by Mr. Glenie, and their use shewn in the solution of some curious problems.

A few of the most interesting properties investigated in this paper are the following:

If from a point in the circumference of a circle, perpendiculars be drawn to the alternate sides of a regular figure of an even number of sides circumscribing the circle, or, which comes to the same thing, beginning with any one side, perpendiculars be drawn to the 1st, 3d, 5th, 7th, &c. sides, the sum of these perpendiculars, the sum of their squares, the sum of their cubes, &c. to the sum of their $\left(\frac{n}{2} - 1\right)$ th, or $\frac{n-2}{2}$ th powers, is respectively equal to the sum of the perpendiculars drawn from the same point to the other sides, viz. the 2d, 4th, 6th, 8th, &c. the sum of their squares, the sum of their cubes, &c. to the sum of their $\frac{n-2}{2}$ powers; but not in powers above $\frac{n-2}{2}$, $n$ being the number of the sides.

Thus, for instance, if a regular hexagon circumscribe a circle, and from any point in the circumference perpendiculars be drawn to the alternate sides, that is, to the sides of an equilateral triangle circumscribing it, the sum of these perpendiculars and the sum of their squares, are respectively equal to the sum of the perpendiculars drawn to the other three sides, and the sum of their squares. For the sum of the perpendiculars to the three sides of an equilateral triangle, is equal to half the sum of the perpendiculars, to the sides of the hexagon, and the sum of their squares in the one, equal to half the sum of their squares in the other. But this does not hold in regard to the sum of their cubes, as the sum of the cubes of perpendiculars to the sides of the triangle is not invariable.

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The same holds true if the perpendiculars be drawn from any point *within* the figure for *odd* powers, and any point either *within* or *out of* the figure, in *even* ones.

But, as the equality between the sum of the powers of perpendiculars, drawn from any point in the circumference of a circle, to the alternate sides of any regular figure of an even number of sides, and the sum of the powers of perpendiculars drawn from the same point to the other sides, existed only to the $\frac{n-2}{2}$ th power; so the equality between the sum of the powers of perpendiculars drawn from the extremities P and Q of any diameter to the sides of a regular figure of an odd number of sides circumscribing the circle, and the sum of perpendiculars from either of these, or any point in the circumference, to the sides of a regular circumscribing figure of double the number of sides, exists only to the $(n-2)$ th power.

This opens a wide field for the geometrical solution of both determinate and indeterminate problems.

The sum of the cubes of perpendiculars drawn from P (one extremity of a diameter) to the sides of any regular figure of an odd number of sides circumscribing the circle, is equal to the sum of the cubes of perpendiculars drawn from Q (the other extremity) to the same. The like property is shewn to obtain with respect to the sums of the fourth powers, and those of the fifth powers; and universally for the sum of the $m$ th powers, if $m$ be any odd number less than $n$.

If a circle be divided into any even numbers of parts, and from the points of division chords be drawn to any point in the circumference, the sum of the fourth powers of these chords is equal to the sum of their squares multiplied by thrice the square of radius.

If the circumference be divided into an even number of equal parts, and from the points of division chords be drawn to any point in the circumference, the sum of the sixth powers of these chords is equal to the sum of their squares, multiplied by ten times the fourth power of radius.

If from any point perpendiculars be drawn to the sides of any regular figure of an odd number of sides, circumscribing a circle, the sum of the parts by which those perpendiculars which are greater than radius, exceed it, is equal to the sum of those parts by which the perpendiculars that are less than radius fall short of it.

Let any regular figure of an odd number of sides be circumscribed about a circle, and let $n$ be any odd number, less than the number of sides of the figure; and from any point within the figure let perpendiculars be drawn to the sides of the circumscribing figure; then the sum of the $n$ powers of the parts by

which those perpendiculars that are greater than radius, exceed it, is equal to the sum of the $n$ powers of those parts by which the perpendiculars that are less than radius fall short of it.

The demonstrations of these and the several other properties contained in the paper occupy about 50 pages.

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*Observations.*—Several of Dr. Stewart's General Theorems have been demonstrated at different times; as some by different geometers in the *Mathematical Repository*, some by M. Carnot, in his *Geometrie de Position*, and some by Lhuillier, in his *Polygonometrie*; but we are not aware of any investigation of these curious theorems, which causes so much generality to flow from so simple a proposition as that demonstrated by Mr. Glenie at the commencement of his paper. Still, however, an air of slovenliness runs through this production which we were not prepared to expect from the inventor of the *Antecedential Calculus*; the whole being thrown together with little regard to order, and the several propositions and corollaries forming an irregular mass, which, by reason of the negligence just alluded to, combined with errors of the press, and omissions of letters in the diagrams, it is sometimes difficult to reduce to a comprehensible shape. As these investigations appear, by the author's acknowledgment, to have been long under his hands, we are sorry he did not find leisure or inclination to direct his well-known talents more completely to the subject, that he might have ascertained which of Doctor Stewart's theorems fail in that generality which has been usually attributed to them, and have shewn which of his own theorems as well as the Doctor's are only particular cases of more universal propositions that apply to the conic sections generally, and are not confined to the circle alone. At present propositions of this kind are looked upon as mere matters of curiosity; but if several of them were extended to the conic sections, after the manner we have suggested, we are much mistaking if they would not be found to illustrate some intricate points of natural philosophy, hitherto never approached with success.

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*The Bakerian Lecture, on the Force of Percussion. By* William Hyde Wollaston, *M. D. Sec. R. S.—Phil. Trans.* 1806. *Part* 1.

It is well known that when equal bodies move with uniform velocities, the estimation of their forces has been a subject of dispute between different classes of philosophers. Leibnitz and his followers have maintained that the forces of bodies are as the masses multiplied into the *squares* of their velocities (a multiple to which Dr. Wollaston gives the name of *impetus*); while

those who are considered as Newtonians conceive that the forces are in the *simple ratio* of the velocities, and consequently as the *momentum* or *quantitas motus*, a name given by Newton to the multiple of the velocity of a body simply taken into its quantity of matter. The Doctor's object is to consider which of these opinions is most conformable to the usual meaning of the force of moving bodies, and to shew that Newton's own explanation of the third law of motion is in no respect favourable to those who in their view of this question have been called Newtonians.

He commences by adducing a leading experiment, in effect the same as one which has been commonly appealed to by both parties, and states the separate conclusions deduced from it. One party is satisfied that equal *momenta* can resist equal pressures during the same *time*; the other party attend to the *spaces* through which the same moving force is exerted, and finding them in the proportion of 2 to 1, are convinced that the *vis viva* of a body in motion is justly estimated by its magnitude and the square of its velocity conjointly.

The former conception of a quantity dependent on the continuance of a given *vis motrix* for a certain *time* may have its use, when correctly applied, in certain philosophical considerations; but the latter idea of a quantity resulting from the same force exerted through a determinate *space* is of greater practical utility, as it occurs daily in the usual occupations of men; since any quantity of work performed is always appreciated by the extent of effect resulting from their exertions. This species of force has been treated first by *Bernoulli*, and afterwards by *Smeaton*, but is, in the opinion of Dr. Wollaston, no where handled by Newton, since his discussions apply to a mere *vis motrix*, or pressure; and in his demonstration of the third corollary to the laws of motion, if he had considered the third law as implying equality of more than mere moving forces, there could have been no occasion to refer to the second law with a view thence to deduce the equality of *momenta* produced.

Dr. Wollaston says, that in practical mechanics it is at least very rarely that the *momentum* of bodies is in any degree an object of consideration: the strength of machinery being in every case to be adapted to the *quantitas motrix*, and the extent and value of the effect to be produced depending upon the *quantitas mechanica* of the force applied, or, in other words, to the space through which a given *vis motrix* is exerted. For able dissertations on this latter kind of force by Smeaton, we are referred to vols. lxvi. and lxxii. Phil. Transac. But as there is one view in which the comparative forces of impact of different bodies were not examined by Smeaton, the present writer undertakes to shew that when the whole energy of a body A is employed without loss in giving velocity to a second body B, the *impetus* which B receives is in all cases equal to that of A, and the force transferred

to B, or by it to any third body C (if also communicated without loss, and duly estimated as a mechanic force), is always to that from which it originated.

After demonstrating this, the Doctor remarks that the times in which the total effects are produced may be varied at pleasure in proportion to the distances at which the bodies are placed from the centre of motion; and observes likewise, that although the intensity of any *vis motrix* is increased by being placed at what is called a mechanical advantage, yet on the contrary any quantity of mechanic force is not liable to either increase or diminution by any such variation in the mode of its application.

Also, since we can by means of any mechanic force consisting of a *vis motrix* exerted through a given *space*, give motion to a body for the purpose of employing its *impetus* for the production of any sudden effect, or can, on the contrary, occasion a moving body to ascend; and thus resolve its *impetus* into a moving force ready to exert itself through a determinate space of descent, and capable of producing precisely the same quantity of mechanic effect as before, the force depending on *impetus* may be said to be of the same kind as any other mechanical force, and they may be strictly compared as to quantity.

Hence an easy method of measuring the force of gunpowder and of steam-engines is inferred, and the Doctor concludes by saying, "In short, whether we are considering the sources of extended exertion or of accumulated energy, whether we compare the accumulated forces themselves by their gradual or by their sudden effects, the idea of mechanic force in practice is always the same, and is proportional to the *space* through which any moving force is exerted or overcome, or to the *square* of the velocity of a body in which such force is accumulated."

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*Observations.*—The title of this paper excited in our minds expectations which the perusal did not verify. We hoped to have seen such an inquiry into the nature of percussion, as would have made all the paradoxes, obscurities, and puzzling difficulties in this subject disappear, by dropping from the consideration that unintelligible force which is supposed to preserve a body in motion or at rest: we expected to have been presented with some cogent reasons either for abandoning, or for acquiescing in, the opinion of Aristotle that percussion and pressure are incomparable; and to have been convinced by such arguments as we should have imagined Dr. Wollaston could readily produce, that the force operating in the penetration by a blow is no way different from a pressure. But instead of this, our attention is unwillingly dragged to a dispute warmly agitated a century ago, respecting the measure of the force of moving bodies; a dispute which every philosopher now knows was merely verbal: and Mr. Smeaton is appealed to as a decisive authority on the measure of mechanical

force, though it is demonstrable that this gentleman's measure (whatever may be due to his authority in *practical* matters) is too vague for philosophical disquisition—is only *nearly* true in any case—and in all cases is *far* from being exact in the first instants of the motion, during its acceleration or retardation.

As to the measures of the quantities of motion impressed on bodies, or destroyed in them, they may be defined by the joint ratios of their quantities of matter and velocities, or of those quantities and the squares of the velocities: yet, as Mr. Atwood remarks, "since definitions affirm nothing, being in themselves incapable of expressing either truth or falsity, if either of these measures were said to be right exclusively of the other, this would be only misapplying the definition by converting it into an affirmation or proposition." In some cases, it is true, one of these definitions applies with more facility than the other; but this we believe is shewn by most late authors on mechanics who have advanced beyond the school-boy elements of equilibrium. That the different measures are reducible to the same origin may likewise, we trust, be easily proved to the satisfaction of those who are moderately versed in the modern analysis. Thus, let a certain force $\varphi$, such for instance as would propel a body B with a velocity U, be capable by its instantaneous action of raising a mass M whose weight is W to a certain height H; and let $g$ denote the force of gravity, while $\dot{t}$ is an evanescent element of time. Then that which has been employed to raise W to the height H will be equivalent to WH, this being the effect produced. But H being a space run over, may be expressed by the product of a velocity V and a time T; and, on the other hand, we have $W = g\,M = \frac{g\,\dot{t}\,M}{\dot{t}}$, where $g\,\dot{t}$ is manifestly the velocity V′ which would be generated by gravity in the element of time $\dot{t}$. Consequently, $W\,H = \frac{V'M}{\dot{t}} \times VT = VV'M\frac{T}{\dot{t}} = u^2\,M\frac{T}{\dot{t}}$, $u$ being the mean proportional between the velocities V and V′: and since T and $\dot{t}$ are homogeneous quantities, we shall have $WH \propto M\,u^2$, the original force being thus resolved into the product of a mass by the square of a velocity, conformably to the notion attached by most foreigners to the term *vis viva*. This force is, notwithstanding, measured by the product BU above: hence appears the truth of what we have already observed, that the warm discussions on the question whether the forces of bodies in motion ought to be estimated by the product of a mass into its velocity, or by the product of the mass into the square of its velocity, are reduced to a dispute about words. Provided we always reason conformably to either definition once adopted, the conclusions will always be the same if our processes are rightly conducted.

*Memoir on imaginary Quantities. By M.* Bue'e.—*Phil. Transac.* 1806. *Part* 1.

This gentleman, whose name will be recollected by most philosophers on account of his able comparison between the mineralogical systems of the Abbé Haüy and M. Rome de l'Isle, has in this paper exercised his ingenuity on the subject of those quantities which are known among mathematicians by the name of impossible or imaginary quantities.

The memoir commences with some remarks on the signs + and — . Considered as signs of arithmetical operations, the one is a symbol of addition, the other of subtraction. Considered as signs of geometrical operations, they indicate *opposite directions*. If the one, for example, signifies that a line must be drawn from the left to the right, the other signifies that it must be drawn from the right to the left.

When a line is described of a determinate length, and in a determinate direction, two things are done: 1. we give to this line its *length*; 2. we give it its *direction*. The first of these operations is, in the opinion of M. Buée, purely *arithmetical*: the second is purely *geometrical*. In the first we make abstraction of the direction, in the second of the length. So that the union of these two operations is reckoned an *arithmetico-geometrical* operation.

Thus each of the signs + and — has two significations entirely different. 1. Put before a quantity $q$ they may design, as has been said, two contrary *arithmetical operations* of which that quantity is the subject. 2. Before the same quantity they may denote two opposite *qualities* having for subject the *units* of which that quantity is composed. In the ordinary algebra, which is considered as a *universal arithmetic*, and in which the contemplation of quality is dropped, the signs + and — can only have the first of these significations. But whenever the result of an operation is a quantity preceded by the sign — , it is necessary, in order that this result may have some sense, to consider some quality: in such cases algebra cannot be regarded simply as a *universal arithmetic*, but as a *mathematical language*.

When it is said that a negative quantity is smaller than zero (less than nothing), the second signification should be kept in view; for it is not the *quantity* which is less than *nothing*; it is the *quality* which is inferior to *nullity*. Thus, if my debts exceed my property, I must be poorer than if I had neither property nor debts.

The two significations of + and — cannot both obtain at the same time relatively to the same + or the same —; for this would cause it to signify at the same time, with regard to the

same sign, both an *abstraction* and a *non-abstraction* of all *quality*. But, 1. These two significations may have place at *the same time* for two different + or —. 2. They may also have place for the same + or the same —, in *two different times*. Lastly, in the algebraical language the units of which a quantity $q$ is composed are the *substantives*, and the signs + and — the *adjectives*.

M. Buée gives the title of *the sign* $\sqrt{-1}$, and not of the *quantity or of the unit imaginary* $\sqrt{-1}$; since $\sqrt{-1}$ is a particular sign joined to the real unit 1, and not a particular quantity. It is a new adjective joined to the ordinary substantive 1, and not a new substantive. To discover the meaning of this sign he directs to draw three equal lines AB, AC, AD, all from the common point A: let AB and AC lie in opposite directions with respect to the point A, so as to form together one right line CAB, and let AD be perpendicular to this line. Then a circle drawn from centre A with radius AB=AC, will pass through the point D; and if we denote the line AB by + 1, the line AC will be — 1, and the line AD, which, by the nature of the circle, is a mean proportional between AB and AC, will be necessarily $\sqrt{-1^2}$, or more simply $\sqrt{-1}$. Thus, according to M. Buée, $\sqrt{-1}$ is the sign of PERPENDICULARITY, the characteristic property of which is, *that all the parts of the perpendicular are equally distant from points placed at equal distances on each side of its foot*. The sign $\sqrt{-1}$ expresses all this, and it is the whole which it expresses naturally. And this sign put before any letter, as $a$ ($a$ signifying a line or a surface) indicates that it is requisite to give to $a$ a situation *perpendicular* to that which it would have received, if we had simply $+a$ or $-a$.

Hence $\sqrt{-1}$ is neither the sign of an *arithmetical* operation, nor of an *arithmetico-geometrical* operation; but of an operation purely *geometrical* or purely *descriptive*, being a sign of *perpendicularity*. But the perpendicularity indicated by this sign must be distinguished from that indicated by the signs *sin.* and *cos.* These latter cannot indicate perpendicularity one without the other, or unless both are attached to the same quantity. Thus *sin.* $a$ and *cos.* $a$ properly indicate the perpendicularity of one to the other; but *sin.* $a$ and *cos.* $b$ do not. On the contrary, $a\sqrt{-1}$ indicates in relation to $a$ a situation perpendicular to those of $+a$ and $-a$. Sin. and cos. are artificial signs: $\sqrt{-1}$ is a natural sign, since it is a necessary consequence of the signs + and — considered as signs of direction.

The *perpendicularity* indicated by the sign $\sqrt{-1}$ is a *quality*. Consequently a quantity accompanied by this sign is not an abstract quantity, since its units are abstract units. By a figurative extension of this sign it will indicate a *mean quality* between two opposite qualities, the one of which is expressed by + and the other by —. *These qualities must be independent of quantity.* Thus, in like manner as any point whatever of the line AD is

equally distant from points of the line CD that are found at the same distance from the point A,—any part whatever of a sum which is neither *possessed nor owing* is in an equal situation relative to equal parts of the sum *possessed* and of the sum *owing*. The *active possession* being therefore expressed by +, and the *debt* or *passive possession* by —, the *negation*, not of the sum but of its *possession*, *whether active or passive*, may always be expressed by $\sqrt{-1}$. Again, $\pm\sqrt{-1}$ has not any arithmetical signification; but $(\pm\sqrt{-1}) \times (\pm\sqrt{-1}) = -1$ has. For $-1$ is a *subtractive square*, and consequently forms a *void space* in the middle of a plane surface. Whence it is inferred that when the question relates to squares or generally to planes, the sign $\pm\sqrt{-1}$ may indicate vacuities instead of perpendiculars.

M. Buée, when treating of the logarithmic properties of the sign $\sqrt{-1}$, says, that if it be regarded generally, not as the impossible root of the impossible square $-1$, but as the sign of the *geometrical operation* by which a perpendicular is raised, we shall have $(\sqrt{-1})^n = \pm n(\sqrt{-1})$; this being equivalent to $(\sqrt{-1})^n = \pm n.T\frac{\pi}{2}$, where $T\frac{\pi}{2}$ denotes the tracing half a circular semi-periphery. The equation obtains whether $n$ be whole or fractional, positive or negative, the idea of perpendicularity then yielding to that of *inclination*.—Again, to pass from the logarithm $\pm\frac{n}{m}T\frac{\pi}{2}$ to its exponential, it will suffice to divide that logarithm by $\sqrt{-1}$.

The author takes a general view of the conic sections having *imaginary* ordinates, which he calls *appendices* to the conic sections. 1. The equilateral hyperbola is the appendix of the circle. Other hyperbolas are appendices of ellipses, and the parabola that of the parabola. But as appendical curves are perpendicular to their original curves, so are these to those; whence the circle is the appendix of the equilateral hyperbola, &c. 2. The common axe to the original curve and to its appendix is the projection of each of those two curves on the plane of its appendix. 3. As all these curves have two axes, namely, that of the abscisses and that of the ordinates, all which has been said with regard to the first axe will hold with respect to the second. 4. As the appendical curves have the same axes as their original curves, these axes have through all their extent, that is, from $-\infty$, to $+\infty$, ordinates corresponding to them. But it is easy to see that what has been said of conic sections, applies equally to all other curves whether algebraic or transcendental. Therefore, supposing the axe described on the plane of this paper, and calling *ordinates* two species of perpendiculars to that axe, namely those which are upon the plane of the paper and those which are perpendicular to it, the following general proposition is established. Any curve

whatever has in all the extent of *each of its axes*, that is to say between $-\infty$ and $+\infty$, as many ordinates as the degree of its equation contains units; and as the degree of a transcendental curve is infinite, the number of its ordinates in the whole course of each axe is infinite.

Finally, it is remarked that to remove imaginary quantities from final equations, is an impossible thing beyond the second degree, unless sines or cosines are employed: and it is shewn that the finite expression of sines and cosines comprises *necessarily* the sign $\sqrt{-1}$.

Also, that the supposition of a radius carrying the sign $\sqrt{-1}$, conducts to the known formulæ for cubic equations, of which the first does not include the sign. If the radius did not carry the sign $\sqrt{-1}$, then would this sign *necessarily* appear again in that first formula, which would then represent the case called the *irreducible* case.

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*Observations.*—The foregoing are the principal conclusions in M. Buée's Memoir of 65 pages. Most of his reasonings are very ingenious, and some of them satisfactory: but we can hardly help thinking it has been more his object to surprise than to convince; otherwise, he might have exhibited fewer paradoxes, and enlarged more upon some of the valuable hints which his paper contains. If we rightly comprehend his meaning, he has struck out one method of avoiding both error and inconsistency in the multiplication of imaginary quantities, by directing to separate each into two factors; though we believe the same thing has been pointed out by Mr. Manning in his Algebra. Thus $\sqrt{-a} \times \sqrt{-b} = \sqrt{-1} \times \sqrt{a} \times \sqrt{-1} \times \sqrt{b} = (\sqrt{-1})^2 \times \sqrt{ab} = -1 \times \sqrt{ab} = -\sqrt{ab}$.

The theorems respecting exponentials are somewhat analogous to the theorem of Bernoulli, that if $r$ be the radius of a circle, the circumference is $= \frac{4 \log. \sqrt{-1}}{\sqrt{-1}} r$; a theorem which is quite useless as a quadrature of the circle; but which may notwithstanding be of service, since it teaches whenever such a quantity as $\frac{\log. \sqrt{-1}}{\sqrt{-1}}$ occurs, that it may be made to disappear by the substitution of a circular arch, and a property common to both the circle and the hyperbola may be obtained.

As to imaginary quantities in general, it has been shewn long ago by Mr. Playfair, that the deductions into which they enter are reducible to an argument from analogy; but that "the laws to which this analogy is subject, the cases in which it is perfect, in which it suffers certain alterations, and in which it is wholly interrupted, are capable of being precisely ascertained." Indeed he has shewn in great measure that the imaginary arithmetic is no more than a particular method of tracing the affinity between the

circle and the hyperbola: and this analogy is traced a little farther by M. Buée: but since the principle of analogy is imperfect, there is still room for farther researches on this subject.

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*The Application of a Method of Differences to the Species of Series whose Sums are obtained by Mr. Landen, by the Help of impossible Quantities. By Mr.* Benjamin Gompertz.—*Phil. Transac.* 1806. *Part* 1.

This is an ingenious paper, and shews how several series which have been summed by means of imaginary quantities may be summed by sines and cosines, &c. But as it is not susceptible of such an abridgment as would be of any use to the reader, we must refer to the Philosophical Transactions both for the method of summation and for the various applications to other purposes.

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*On the Quantity and Velocity of the solar Motion. By* William Herschel, *L. L. D. F. R. S.—Phil. Trans.* 1806. *Part* 1.

This paper contains much curious speculation, but very little that deserves a higher title. It however exhibits some interesting tables, from one of which we extract Dr. Herschel's assigned relative distances of 36 fixed stars: these are—Sirius 1.00, Arcturus 1.20, Capella 1.25, Lyra 1.30, Rigel 1.35, Procyon 1.40, Aldebaran 1.40, Pollux 1.42, Spica 1.44, Antares 1.46, Altair 1.47, Regulus 1.48, $\beta$ Leonis 1.50, $\beta$ Tauri 1.50, Fomalhaut 1.50, $\alpha$ Cygni 1.60, Castor 2.00, $\alpha$ Ophiuchi 2.00, $\alpha$ Coronæ 2.00, $\alpha$ Serpentis 2.00, $\alpha$ Pegasi 2.00, $\alpha$ Hydræ 2.30, $\alpha^2$ Libræ 2.40, $\gamma$ Pegasi 2.50, $\alpha$ Arietis 2.50, $\alpha$ Ceti 2.80, $\alpha$ Herculis 3.00, $\beta$ Virginis 3.00, $\gamma$ Aquilæ 3.00, $\alpha^2$ Capricorni 3.50, $\beta$ Aquilæ 4.00, $\alpha'$ Capricorni 4.20, $\alpha'$ Libræ 6.00.

Towards the conclusion of the Doctor's paper he says, "It appears that in the present state of our knowledge of the observed proper motions of the stars, we have sufficient reason to fix upon the quantity of the solar motion to be such as by an eye placed at right angles to its direction, and at the distance of Sirius from us, would be seen to describe annually an arch of 1.″ 116992 of a degree; and its velocity, till we are acquainted with the real distance of this star, can therefore only be expressed by the proportional number of 1116992."

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*Observations.*—The Doctor's comparative estimate of the distances of the stars is founded upon observations of their relative

brightness ; a method which though it is by no means a certain one, carries with it so much probability as renders it worthy of attention till some more accurate methods shall be discovered. As to the determination of the quantity of the solar motion, we confess that if astronomical orthodoxy requires a *bona fide* adoption of it, we must of necessity sustain the odium of being classed among the heterodox.

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*On comparative Micrometer Measures. In a Letter from the Rev. Dr.* J. A. HAMILTON, *Dean of Cloyne, to the Rev.* J. BRINKLEY, *F.R.S.—Trans. Irish Acad. Vol.* 10.

IT having been suggested to Dr. Hamilton in the year 1794, that a comparative view of the measures of the heavenly bodies, made under similar circumstances, with the different kinds of micrometers that are now most generally used by astronomers, might be of considerable service ; as well in confirming the determinations of the values of the diameters, from former observations, as in deciding on the merits of the different instruments, and shewing at one view, a sort of harmony of micrometers ; in consequence of this suggestion, the Doctor set about making comparative observations of the measures of the sun's diameters, as taken with the old wire micrometer made in the best manner by Mr. Dollond ; with his divided object-glass micrometer ; and with a ten-inch reflecting sextant, executed in a very capital style by Messrs. Troughton.

As specimens of the comparative results furnished by these instruments, we shall select the first four observations on the sun's semidiameter made with all the three kinds of micrometers.

| 1794. | | S. Dr. ⊙ | Semidiam. ⊙ as given in Naut. Al. |
|---|---|---|---|
| Sept. 3. | D. O. G. micr. - - | 15′ 56.″ 01 | |
| | Wire micr. - - - | 15′ 55.″ 9 | |
| | A set of ten, all agreeing on the sextant, on the limb, and arch of excess - - - - - - | 15′ 55.″ | 15′ 55.″ 4 |
| | I T S V | | |
| Sept. 11. | D.O.G.micr. 3.5.1.19 | 15′ 56.″ 54 | |
| | Error of V——+2 | | |
| | R D | | 15′ 57.″ 4 |
| | Wire micr.—— 15.41 | 15′ 57.″ 1 | |
| | Sextant, 15′ 55″+3″ | 15′ 58.″ 0 | |
| | 4 | | |

| 1794. | | S. Dr. ⊙ | ⊙ Semidiam. from Naut. Alm. |
|---|---|---|---|
| Sept. 27. | D. O. G. micr. - - - | 16′ 1.″ 85 | |
| | Wire micr. - - - - | 16′ 1.″ 95 | 16′ 1.″ 7 |
| | Sextant, + 3″ - - - | 16′ 1.″ 70 | |
| Oct. 4. | D. O. G. micr. - - - | 16′ 3.″ 76 | |
| | Wire micr. - - - - | 16′ 4.″ 1 | 16′ 3.″ 6 |
| Oct. 6. | Sextant, + 3″ - - - | 16′ 3.″ | |

It likewise appears by comparing the divided object-glass micrometer's measures of the sun's diameters of Dec. 15th, 1794, and of June 19th, 1795, that the difference of the perigeal and apogeal diameters of the sun was found to be 65″.14. De la Lande found this difference 64″.8; but he calls it, in round numbers, 65″.

*Observations.*—It hence appears that good micrometers of either of these constructions, furnish results corresponding as nearly with one another and with theory as can reasonably be expected; though, on the whole, we are disposed to prefer the divided object-glass micrometer. Its advantages as stated by Dr. Hamilton are, the large scale, the fine images formed, and the facility of measuring diameters in every possible direction. Its imperfections are, that to different eyes, and under different circumstances of the same eye, the length of the focal distance that suits distinct vision will vary; and of course the quantity of measures given by the scale are liable to a small variation. The goodness of the telescope is also in some degree impaired by the application of this contrivance of a divided object-glass.

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*On the Satellites and Belts of Jupiter. By Mr.* John Snart — *Phil. Mag.* No. 98.

Mr. Snart, after making some remarks on the salutary effects of the most tempestuous weather, proceeds to inform us that on Friday the 11th of July last about 10 o'clock P.M. after our atmosphere was pretty much attenuated by the discharge of vast quantities of rain, much thunder, lightning, &c. he, and an acquaintance, had a view of the third and fourth satellites of Jupiter by the naked eye: a fact which he completely verified by subsequent observation with a good night telescope.

Mr. Snart then proceeds to give the *rationale* of the mutations of Jupiter's belts, which he thinks are analogous to the motions of clouds carried about by the trade-winds in our torrid zone. "If," says he, "we were to be elevated to a great height above our

atmosphere, it is plain that this current must give the clouds a lineal direction, by which they would assume the appearance of one or more belts or girdles passing across the equatorial parts of the earth, and which belts would change their form and dimensions to an aërial observer in six months in a similar manner to those of Jupiter in 5¾ years (equal to half a year in that planet). Mr. Snart, therefore, "thinks it but fair reasoning to suppose that Jovian trade-winds, or something equivalent thereto, carrying his clouds in an equatorial direction, produce those mutations on the face of that planet which we call belts, and for which phenomenon he has never seen any colourable conjecture."

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*Observations.*—We give Mr. Snart full credit for his ingenuity in inventing this hypothesis to account for the phenomena of Jupiter's belts; but we think he would have acted commendably had he inquired a little into the opinions of other philosophers on this point, or at least had consulted the most reputable treatises on astronomy, to trace the extent of former speculations on the nature of these belts, before he had given publicity to his own. The honour of devising an hypothesis that has been previously started, in these times when so many philosophers and philosophists are contending for the palm, is so problematical and doubtful, that it ought to engender circumspection. Now, of the curious astronomical performances published within the last ten years we have only consulted four; and as Mr. Snart has never yet "seen any colourable conjecture," we will extract for his information a passage from each. 1. Biot, in his *Traité elémentaire d' Astronomie Physique*, when speaking (at pa. 475) of the different indications of an atmosphere to each planet, says, "Pour Jupiter, elle l'est par les variations irregulieres de quelques-unes de ses taches qui semblent autant de *nuages transportés par les vents.*" 2. Laplace, speaking (at pa. 37 of his *Exposition du Systême du Monde)* of Jupiter's spots and belts, says, "Les variations de quelques-unes de ces taches, et les différences sensibles dans les durées de la rotation conclue de leurs mouvemens, donnent lieu de croire qu'elle ne sont point adherentes à Jupiter: elles paroissent être *autant de nuages que les vents* transportent avec differentes vitesses, dans une atmosphère très-agitée." 3 and 4. Mr. Vince, at pa. 234, vol. i. of his *Complete System of Astronomy*, and Mr. Gregory, at pa. 260 of his *Treatise on Astronomy*, speaking of Dr. Herschel's observations on Jupiter's spots and belts, say—"This, he observes, is agreeable to the theory *of equinoctial winds*, as it may be some time before the spot can acquire *the velocity of the wind*; and if Jupiter's spots should be observed in different parts of its year to be accelerated and retarded, it would amount almost to a demonstration of *its moonsoons*, and their periodical changes." Thus it would seem that some "colourable conjectures" are to be found; and, if our mental optics do not greatly

deceive us, it will farther appear that these conjectures are very nearly of the same colour as those with which Mr. Snart has favoured the world.

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*A simple Way for determining the exact Time of Noon; also a Way to obtain a Meridian Line on a small Scale. By* Ez. Walker, *Esq.—Phil. Mag.* No. 98.

The method recommended by Mr. Walker, and which he acknowledges "has not the merit of *much* originality," is this: Near the top of a room facing the south fix a plate of metal with a circular hole in it, for the sun to shine through from eight or nine o'clock in the morning until three or four in the afternoon; then by means of a line and plummet, determine the point upon the floor which is directly under the centre of the hole, and from that point, as a centre, draw several concentric semicircles. Having made choice of some clear day near the summer solstice, make the room nearly dark, and about three or four hours before and after noon mark the points where the northern as also the southern limb of the sun's image crosses those semicircles, and there will be several curves included between those points, through the middle of which a right line being drawn from the centre of the semicircles is a meridian line. After the line has been drawn in this manner, it must be examined by succeeding observations, and corrected if necessary, by which means a line may be drawn exceedingly near the true meridian.

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*Observations.*—Notwithstanding the usual precaution of having several concentric circles described as here recommended, it may still happen that it will be impossible to get two equal shadows on the same day: this is an inconvenience which may be remedied by taking *any* three observations instead of two, in one day. Useful rules for ascertaining the meridian by three observations may be seen at pa. 31 of *Leybourne's Dialling*, pa. 44 of the Dialling in vol. v. Ozanam's *Course of Mathematics*, and pa. 260, vol. iii. of Hutton's Translation of *Montucla's Recreations*. It may not, however, be amiss to remark, that the instant of true noon marked upon a meridian described conformably to any of these rules, generally differs from the *mean noon*: yet as we know the equation of time for every day, we may trace daily on one side or the other of the meridian the direction and the limit of the shadow at the instant of mean noon. Thus we shall have a series of points which mark about the true meridian the successive mean meridians of the sun. The curve which unites their extremities must evidently meet with the true meridian in four points, corresponding to the four periods of the year where the equation of

time is nothing. Moreover, it must be a curve that re-enters upon itself, since the equation of time reassumes the same values after each revolution : so that this curve will be formed nearly like the figure 8. But it will not be symmetrical, because the epochs at which the equation of time becomes nothing are not equally distant. This curve is called the *mean meridian*, and when it is traced about the true meridian on sun-dials, the signs corresponding to the various seasons are marked near it, whence it is easy to ascertain the portion of the curve which answers to each part of the year. There exists a meridian of this kind, traced by M. Bouvard, in the Luxembourg at Paris.

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*Enumeration of several Cases of Ships which have been struck by Lightning; the destructive Effects having acted in a vertical Direction towards the Centre of the Earth, and never horizontally. By* James Horsburgh, *Esq.—Phil. Jour.* No. 58.

In this letter several cases are described of ships being struck by lightning, from the various circumstances attending which the following general observations are deduced—1st, That the lightning always appears to embrace one of the mast heads at first, and proceeds downwards—2dly, That the parts of masts which are covered with tar and blacking, are not so liable to be rent by the lightning as the parts where they are clean scraped, or scraped and covered with tallow—3dly, That the yards are seldom or never damaged by lightning; although the masts to which they are fixed may be rent into pieces by it. But Mr. Horsburgh does not determine whether this may be owing to the horizontal position of the yards across the masts, or their being covered with blacking, or a coat of black paint.

Mr. Nicholson thinks that the circumstance of the yards of ships being seldom or never injured by lightning arises not from their horizontal position, but from their lying out of the circuit or immediate path of the lightning from the clouds to the earth.

Mr. Horsburgh gives an important caution in his postscript, where he remarks that ships navigating in seas or places where lightning is frequent, should be careful to place no cargo of an inflammable nature near the masts: for the electric matter is frequently conducted by them into the hold, as happened to the King George in Canton river; and a few years ago to the Queen Charlotte, which with all her crew were blown to atoms, at Diamond Harbour in the river Hooghley, during a night when much thunder and lightning prevailed.

*On Thunder Storms. By Mr.* Sam. Berey.—*Phil. Jour.* No. 59.

This writer, after duly appreciating the discovery of Dr. Franklin, that lightning and the electrical fluid are precisely the same, gives it as his own opinion that the discharge of an electrified cloud is not the sole cause of thunder, conceiving it almost impossible that so large a quantity of the electrical fluid could be accumulated, particularly after the first discharge, when the equilibrium is restored, and the clouds, being full of wet vapour, are consequently become good conductors. He thinks it more probable that thunder is caused by the explosion of hydrogenous and oxigenous gas fired by the electrical fluid. It is well known that both these gases are constantly produced on the surface of the earth; that stagnated ponds, swamps, &c. emit carbonated hydrogen gas; and that plants are continually decomposing the air of the atmosphere, by imbibing the nitrogen, and emitting the oxigenous gas. This decomposition and the formation of these gases, go on more rapidly in warm than in cold weather.

If thunder were caused merely by the discharge of an electrified cloud, and not by the gases exploding, the heaviest clap would always attend the largest and most vivid flash of lightning, which is not constantly the case.

When the lightning takes an horizontal direction, there is frequently either no thunder, or a very small clap; but when it takes a perpendicular direction, the thunder is the heaviest. This is probably owing to the gases, which are formed during the storm, being collected above in considerable quantities. When Mr. Berey speaks of the lightning taking these different directions, he does not mean the electrical fluid, which appears blue, and frequently in a zig-zag form, but that reddish light which surrounds it, and which has the appearance of a shadow, and may be frequently observed to extend to a great distance from the blue light, and which Mr. Berey conceives to be the gases in the act of exploding.

In hot weather, when it is rather windy, lightning is frequently observed unaccompanied by thunder; in this case it appears that the wind has either blown the mixed gases abroad, or prevented their union. And thus all the other phenomena attending a thunder-storm may be easily accounted for upon the same theory.

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*Observations.*—This hypothesis suggests a very wide field of inquiry and discussion, into which we regret that the limits we are obliged to assign ourselves will not permit us to enter. Those

who wish to make such inquiries and experiments as may enable them to decide the question, will do well to recollect it as an established fact, that the simple solution of water in air produces electricity, and that this is the chief operation in nature connected with the state of the atmosphere; it being thus that the watery vapours from all bodies, and particularly the copious exsudation of plants, disappear in our atmosphere. The opposite state of electricity will, doubtless, be produced by the precipitation of this vapour: and it is a fact established beyond all controversy, that the mere expansion and condensation of the air destroys the equilibrium of electricity. The joint effects of these, and other powerful causes, dependent upon chemical operations, have not yet been sufficiently explored.

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*Account of an Appearance of Brighton Cliff, seen in the Air by Reflection. By Dr.* A. P. Buchan.—*Phil. Jour.* No. 58.

As Dr. Buchan was walking on the cliff about a mile to the eastward of Brighthelmstone, on the morning of the 28th November 1804, while watching the rising of the sun, he turned his eyes directly towards the sea just as the solar disk emerged from the surface of the water, and saw the face of the cliff on which he was standing, represented precisely opposite to him at some distance on the ocean. The Doctor called the attention of his companion to this appearance, and they soon discerned their own figures standing on the summit of the apparent opposite cliff, as well as the representation of a windmill near at hand. The reflected images were most distinct precisely opposite to where they stood, and the false cliff seemed to fade away, and to draw near to the real one, in proportion as it receded towards the west.

This phenomenon lasted about ten minutes, or till the sun had risen nearly his own diameter above the surface of the ocean. The whole seemed to be elevated into the air, and successively disappeared, giving an impression very similar to that which is produced by the drawing up of a drop-scene in the theatre. The surface of the sea was, at the time, covered with a dense fog, of many yards in height, and which gradually receded before the rays of the sun.

This fact, Mr. Nicholson remarks, is of great value, as a proof that the effects described under the denomination of *Fata Morgana*, are not produced merely by light transmitted through the air, or reflected at small angles; but also by direct opposite reflection from some medium suspended in the air.

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*Observations.*—Those who are not acquainted with the curious phenomena of the *Fata Morgana*, may consult the first vo-

lume of the quarto series of *Nicholson's Journal*, or the optics in *Cavallo's Natural Philosophy*. No satisfactory theory of these appearances has yet been advanced, and we shall not attempt to speculate upon them here. The fact, however, may furnish us with a more plausible reason for the non-appearance of many such islands as have formerly been discovered by navigators, but not landed upon. That which was thought to have been an island may have been merely an optical illusion, something similar either to the Fata Morgana, or to the appearance observed by Dr. Buchan; and in this case, its not being found by future navigators may arise from their not being placed in exactly the same circumstances with regard to reflected, refracted, or transmitted light, as the preceding voyagers. This, at all events, is less revolting to the mind than the supposition that such islands are blotted from the face of creation by being sunk in the ocean.

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## *Account of the late Eruption of Mount Vesuvius.*

An account of the eruption of Vesuvius, in the beginning of June last, has been copied into some of our journals from the *Moniteur* of June 22: as we are not in the habit of placing full reliance upon anonymous newspaper statements, we should have passed this over unnoticed, had it not contained a description of the progress of the lava, which, although we have received evidence of its correctness, from other sources, is widely different from the conception usually formed of it.

The writer of the account from which we now extract, had always imagined that the substance of the lava, resembling melted glass, ran in the same manner, and advanced uniformly like a river of fire; and indeed he still thinks it probable that in a great number of eruptions it actually exhibits this appearance. On the present occasion, however, he saw nothing but an accumulation of stones, some of which were of prodigious magnitude, heaped one upon another to the height of fifteen or twenty feet, and about half a mile in breadth. This formidable mass advanced slowly, following a progression produced solely by the falling of the different bodies, between which there was no adhesion, and which, in obedience to the impulsion they had received on issuing from the crater, rolled from the most elevated point and covered the surface of another stratum. In this manner the stones rolled over one upon another, till the front rank having attained the same height as that which produced it, begun in its turn to pour down the ignited bodies that came tumbling upon it.

All this intestine motion was accompanied with a noise, resembling the decrepitation of salts, but much more loud and brisk. The fire was fed by various combustible matters, as sulphur,

bitumen, and metals, which might be known by their flames; but there was no appearance either of complete fusion or of the commencement of it. The stones resisted the pressure of a stick which the observer several times endeavoured, but in vain, to thrust into them.

Meanwhile the devastation occasioned by the progress of the lava presented a horrid spectacle. The trees which supported the vines and the vines themselves, were burned by the extreme heat of this mass of matter, even before it reached them; and the bright and clear light produced by their combustion, indicated the exact contour of the progress of the lava. The walls of inclosures and of houses, calcined by the heat, crumbled to pieces before this moving mountain, or were thrown down by the force of the impulsion. Sometimes, however, instead of overturning an obstacle, the lava turned aside, and left it standing; a variety of action for which no reason could be assigned.

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*Observations.*—The circumstances attending the progress of the lava in the eruption of August 12th, 1805, were nearly the same. An eye-witness of that eruption says, "The lava does not run in liquid waves; it resembles an immense quantity of coals on fire, which an invincible strength had heaped up and pushed on with violence. When it met with a wall, it collected to the height of seven or ten feet, burnt it and overthrew it at once. I saw some walls get red hot, like iron, and melt, if I may use the expression, into the lava. In its greatest speed and on a *horizontal road* I reckoned that the torrent travelled at the rate of *eighteen inches a minute.*"

We could wish that future philosophical observers would ascertain the velocity of the lava under different circumstances of distance from the crater, and of inclination from the horizontal plane.

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*Facts relative to the Art of Shaving.—Phil. Jour.* No. 58.

We give this title in conformity to our general maxim of noticing every article that assumes the garb of originality, but it is a subject into which we shall certainly not enter minutely. Shaving is an *art*, it is true, and so are wig-making, wig-block-making, and cutting of corns; and each, for aught we know, contributive to the ease and comfort of life: "but we conceive they are not fit subjects for scientific publications. The line of exclusion must be drawn somewhere, and we think it must necessarily be done in such manner as will shut out the directions of *Packwood* for shaving on the gallop, or the interesting dissertations of *Mr. Ross* on the "genius and talents of the first artists to complete his exhibition of ornamental hair in all its luxuriant varieties,

where the elegance of nature and convenience of art are so blended, as at once to rival and ameliorate each other."

" Witness the shop, where now the splendid show
" Of princes, heroes, ladies—all arow;
" Of wax or plaster figures, rosy red,
" Proves how a wig may grace an empty head."

As to the present paper, we can hardly help apprehending that its principal object is to advertise " the Egyptian razor powder;" a powder which it is possible may be " the black powder obtained by triturating tin with a little mercury," which Mr. Nicholson has heard " praised," but has " not tried."

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*Inquiry respecting the Cause why Men cannot swim without previous Education as well as Brutes. From a Correspondent,* R. B. *With various Observations by the Editor.—Phil. Jour.* No. 58.

*Letter from a Correspondent, affirming that Objects can be seen by the human Eye under Water; with additional Experiments by the Editor.—Phil. Jour.* No. 60.

These also are articles on which it would be inconsistent with our plan to dwell.—Some instructions on the art of swimming by Mr. Nicholson, whose observations are always sensible and often valuable, may just be mentioned. He gives an account of a man who had not learned to swim, but who in a case of extreme danger (in consequence of his slipping from the deck of the ship Worcester into the Ganges) supported himself by acting conformably to instructions given him; the principal of which instructions was, *to keep his hands down* in the water. Men, Mr. Nicholson remarks, are drowned by raising their arms, the unbuoyed weight of which depresses the head. Other animals have neither notion nor ability to act similarly, and therefore swim naturally.

When a man falls into deep water, he will rise to the surface by floatage, and will continue there if he do not elevate his hands. If he move his hands *under the water* in any manner he pleases, his head will rise so high as to allow him free liberty to breathe. And if he move his legs as in the action of walking (or rather of walking up stairs), his shoulders will rise above the water; so that he may use less exertion with his hands, or apply them to other purposes. These plain directions we recommend to the recollection of those who have not learned to swim in their youth; as they may be found highly advantageous in preserving life.

*Remarks on achromatic Eye-pieces.* *By* DAVID BREWSTER, *A. M.* —*Phil. Jour.* No. 59.

THIS article is in reply to a writer under the signature of *Juvenis*, who, in No. 57 of the Journal, seemed to question the accuracy of a rule for achromatic eye-pieces given by Mr. Brewster in his Appendix to *Ferguson's Lectures*, and to imagine that no combination of lenses whatever can form an eye-piece capable of removing the chromatic aberration. Were this principle to be admitted, the ingenious eye-pieces by which Dollond and Ramsden have rendered their telescopes superior to those of every other artist, would be liable to the same imputation. Mr. Brewster says he could easily demonstrate, were it necessary, that an eye-piece consisting of two lenses, whose focal lengths, reckoning from that next the object, are as the numbers 3 and 1, and whose distance is equal to the difference of their focal lengths, will almost wholly remove the aberration of colour. But he thinks it a sufficient vindication of his rule to explain the reason why the error arising from the different refrangibility of the coloured rays, may be corrected by a judicious combination of lenses *of the same refractive and dispersive power*. This he does quite satisfactorily, but after a manner that cannot be rendered very obvious without the use of a diagram.

*Facts and Observations relating to the Winds, Waves, and other Phenomena by which the Surface of the Sea is affected.* *By* JAMES HORSBURGH, *Esq.*—*Phil. Jour.* No. 60.

THE statements in this paper are more particularly applicable to the Indian and Chinese seas, where Mr. Horsburgh made his observations.

He remarks that the smooth regular waves of a steady breeze are augmented by the rise of a low cloud, though the breeze is diminished. It seems as if those clouds had some affinity with the surface of the sea. The effects proceeding from these dense clouds during their passage over the zenith, are the opposite to those experienced from a regular squall: for this generally first makes its appearance by a small arched cloud, either rising from the horizon, or formed at a small distance above it; which rises gradually until near the zenith. When the preceding clouds of the arch approach the zenith, the strength of the squall commences, and continues strong during the passage of the clouds over it, which is the reverse of what has been noticed as the result proceeding from dense clouds generated at high altitudes. Currents

also, or ripplings on the surface of the sea, seem to have an affinity with the wind.

Upon banks or flats the wind is suddenly and considerably less than on the deep water: this has been experienced repeatedly; and Mr. Horsburgh has found a ship hardly manageable from a deficiency of wind on the verge of a bank with shoal water on it; when at a small distance from it in deep water, some of the light sails were obliged to be taken in, the regular breeze over the surface of the deep water prevailing so strong.

Mr. Horsburgh then describes the very strong ripplings in the Indian sea, which are accompanied with a temporary diminution of wind; and proceeds to the phenomena of currents. In the ocean and also in narrow seas, currents frequently raise the sea and agitate the surface greatly.—When the wind and current coincide in their direction, the sea generally is moderately smooth; but it is agitated, and turbulent waves are produced, when the current runs in a contrary direction to the wind. This is a general remark among nautical men which often holds good; although it does not always ensue: for turbulent waves are sometimes the effect of a strong current, when its direction and that of the wind agree. It is singular that currents are very changeable in some parts of the ocean far distant from land; particularly near the equator. Mr. Horsburgh has several times in low latitudes experienced the current run upwards of 60 miles in 24 hours to the eastward or westward; then change suddenly, and set with equal velocity in the opposite direction, during the subsequent 24 hours. The rise and fall of tides in most parts of the globe appear to be much greater in high latitudes than within the tropics, though currents seem to prevail more here than in situations of the former kind. In the northern Atlantic they are seldom strong, but are frequently so near the equator, between the coast of Guinea and the American continent. About the southern limit of the Maldiva Isles, near the equator, and to the eastward of the Philippine Islands, they are frequently strong and changeable. In latitude 40° south, near the Cape of Good Hope, a strong current commenced suddenly, which produced a mountainous sea, when there was very little wind: it continued to run strong for a day, then suddenly abated, and set in another direction with a gentle velocity; the high sea falling at the time.

Smooth and agitated portions of the sea prevail much in sultry weather, when the airs are faint. The perspective causes the distant sea to appear roughest. Smooth veins on the surface of the sea prevail to the westward of the Laccadiva Islands, between these and the island Socotra, in the months of March and April, and are most perfectly depicted during brisk winds. In these months the winds blow from the northward, in moderate and strong breezes, at a few degrees distance from the coasts of Canara and Concan; and are mostly from N.N.W. to N. by E.: these

winds do not blow uniformly, although the sky is generally clear, but come in gusts at short intervals; particularly in the night, the breezes being then stronger than in the day.

It is very common to observe with these winds smooth veins on the surface of the sea, which extend in lines parallel to each other, and to the direction of the wind: they are often discernible in the night when the moon exhibits no light, being so different in colour from the other parts, these having a black appearance, occasioned by the fresh (or brisk) breezes agitating the surface and producing a great contrast between these agitated portions and the smooth veins.

Another curious phenomenon has frequently been observed to accompany these northerly winds, which is, in March or April ships that are bound to Bombay or Surat, frequently have their rigging covered with white dust, although several degrees distant from the coast of Canara or Concan. The northerly and north-north-west winds, blowing from the coast of Persia, over an extensive surface of sea (at least 10 or 12 degrees), it is difficult to judge what can occasion the dust, if it be not generated in the atmosphere, which is in these months sometimes impregnated with a dry haze.

The gulf weed in the Atlantic Ocean is deposited in long parallel veins in the direction of the wind: and in general it does not appear to be more than from 12 to 20 hours in changing its direction.

Mr. Horsburgh agrees with Mr. Nicholson in his opinion expressed in a former number of his Journal, that the squall is a *descending* wind. A remarkable instance in proof of this occurred in Malacca Strait during a calm day, when a fleet was in company: a breeze commenced suddenly from a dense cloud; its centre of action seemed to be in the middle of the fleet, which was much scattered. The breeze spread in every direction from a centre, and produced a singular appearance in the fleet, for every ship hauled close to the wind as the breeze reached her, and when it became general, exhibited to view the different ships *sailing completely round a circle, although all hauled close to the wind.*

In the ocean it frequently happens that two swells run in directions opposing each other; at other times they cross each other obliquely; and sometimes three swells running in different directions, meet and run through each other; and continue to do so for a day or longer time, each retaining its own direction and apparent regular velocity.

In December 1803, at anchor on the eastern sea-reef, at the entrance of Hooghley river, a gale of wind commenced, and blew from the northward, off the land: at the same time a heavy squall came rolling in from the sea, directly in opposition to the prevailing wind; this caused an apprehension that the gale would change suddenly, and blow from seaward, which did not happen.

On the arrival of several ships soon after, the cause of the heavy swell rolling into the entrance of the river was ascertained; for these ships experienced a strong gale from the southward, which brought them within about thirty leagues of the entrance of the river. This strong gale from the southward had forced a heavy swell greatly beyond its limit, although this swell must have met with great resistance from the strong northerly wind blowing against it.

Mr. Horsburgh's barometrical observations confirm in great measure those of Mr. Flinders (see Retrospect, No. IV. pa. 13, &c.), both as to the two elevations and depressions regularly every 24 hours, and with regard to the continuance of the mercury at greater heights with the wind from the sea, than with land winds.

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*Observations.*—This paper is valuable in so far as it relates to subjects on which we require the copious and extensive statement of facts with a view to infer the true doctrines. On the general subject of currents we know of no satisfactory theory: nor indeed are we acquainted with any hypothesis which will apply to the irregular winds that are experienced on different regions of the earth's surface. The phenomena of *trade-winds* have been ingeniously accounted for by Mr. Hadley in Phil. Trans. vol. 39 (vol. 8, New Abridgment), and by Mr. Dalton in his Second Essay: yet the theory of Dr. Halley, though quite inadequate and immechanical, seems still to be most generally adopted. Indeed, when we reflect attentively upon the nature of winds in general, when we consider all the causes which disturb the equilibrium of the atmosphere; the great mobility due to its fluidity and its elasticity, the influence of heat and cold upon the latter, the immense quantity of vapours with which it is charged and discharged alternately, the mutual effect of contiguous air and water in motion, the varied attractions of the sun and moon upon the aerial fluid, and finally the changes produced by the earth's rotation in the velocity of the atmospherical moleculæ at different parallels of latitude; we shall no longer be astonished at the inconstancy and variety which infringe upon the regularity of some of our winds, and render it so extremely difficult to reduce the whole to laws wearing the semblance of certainty.

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*Account of the principal Inventions by which Timekeepers have been brought to their present Degree of Perfection. Anon.—Phil. Jour.* No. 58.

The discoveries in the art of clock-making since the middle of the seventeenth century, of any considerable importance, are noticed in this paper; those previous to this period are passed over, it is supposed, on account of their comparative insufficiency as accurate measurers of time.

Clocks, and all other timekeepers, consist of two principal parts, the machinery which communicates and divides the motion, and that which regulates it to a required degree of uniformity: the latter, being the most important, has engrossed the attention of improvers; the former has received the sole improvement of the *going fusee*, unless the invention of the *remontoir* can be classed under that head.

The *remontoir*, one of the first improvements proposed since the above period, is a contrivance for winding up the spring, or other power, which gives motion to the regulator, at short intervals, to render its operation more nearly uniform. In this case, this spring impels the wheel directly in contact with the regulator; and the rest of the machinery of the clock is merely employed in producing the effect mentioned. A description of a *remontoir* movement is to be found in the *Horologium* of Huygens, p. 18; and though Berthoud mentions its having been known in 1600, it is probable Huygens conceived the idea of it without any previous hints from others. The principle of this contrivance has been adopted by Harrison and others, but has never become general. It is supposed we possess more simple means of attaining the same advantage.

The greatest improvement ever made in regulators of time was the invention of the pendulum. Huygens is certainly the first who applied it efficaciously to clocks, as explained most satisfactorily in his *Horologium*; though he was not the first who thought of it as a measurer of time, nor perhaps the first who thought of applying it to clocks. But the invention of the dead-beat and anchor escapement, by which the complete practical benefit of the pendulum was obtained, was not the result of the investigations of Huygens to procure cycloidal vibrations; and by permitting only narrow vibrations, obviate the inconveniencies of his method. Huygens also invented the application of a pendulum with a conical or circular motion, which the author of this paper asserts did not answer his expectation, but he does not mention his authority for this statement, directly contrary to Huygens' positive declaration in the Horologium, p. 157, that he constructed them *successfully*. *Plura tamen hujus generis, non sine successu, constructa fuere.*

Huygens constructed a timekeeper for finding the longitude at sea, maintained by a spring, and regulated by a pendulum, fixed so as to be least affected by the motions of the ship. Timekeepers on this construction were tried at sea with various success, which Huygens ascribes to the bad management of those who had the care of them, and our author, to the nature of their formation.

The pendulum is certainly the best regulator for fixed timekeepers; but for those required to be portable, the balance is

preferable. Dr. Hooke was the first who thought of attaching a spring to the balance to supply a power to it, similar to that of gravity on the pendulum; though it is doubtful whether he used a spiral spring for this purpose. The priority of this application of the spring is disputed between him and Huygens; but Dr. Hooke seems, for various reasons, to have the best claim to it.

The next improvement was the art of *jewelling* the parts of greatest friction in timekeepers, in order to reduce it, and prevent the alteration of figure on the surfaces from wear.

The art of drilling small holes in rubies, necessary for the jewelling, was proposed in France during the regency, by M. Fatio, a Genevese, and was since successfully used by Harrison and others.

In the beginning of the last century, Henry Sully, an Englishman, was one of the first who carried the manufacture of watches to its present state of perfection: he laboured in making marine timekeepers, on a plan somewhat similar to that of Huygens, but died before he had fully proved them; but the author of this paper thinks that they are subject to all the inconveniencies of Huygens' method, and can never be useful for portable timekeepers.

Sully published a variety of ideas and inquiries on this subject, but the only one of them which has been much used is the application of friction rollers to the pivots of timekeepers; and this method has been since frequently employed in France.

It is probable Harrison had made some progress in the improvement of timekeepers before Sully's death: he was the first who succeeded to the extent required, for the great reward offered by Parliament. Most parts of his construction have been since superseded by other methods, but the principles of them are still used. Mr. Harrison invented the *going fusee*, in which contrivance a force is still supplied to act on the regulator, while the main spring is winding up, by the intervention of a secondary spring constantly kept bent by the former while in action, and set at liberty when this is restrained. This invention is reckoned of great utility, to preserve an uniform action, and is used in all good watches. It is of peculiar importance for those timekeepers which have not the power of setting themselves in motion, which sort are esteemed the best.

Harrison also invented a compensation for the effects of heat and cold, at that time perfectly new: Graham proposed doing this by quicksilver in pendulums; but Harrison effected the same purpose by two solid metals in his gridiron pendulum, and afterwards applied the same principle to portable timekeepers, by rivetting two thin pieces of brass and steel together, which, by the greater alteration of dimensions of the brass on change of temperature, became convex on the brass side in hot weather, and on the steel side in cold weather; whence, on fixing one

end, the other moved according to the changes of heat and cold, and was made to contract or increase the length of the balance-spring by two pins, attached to the compensation piece, which the spring touched alternately in its vibrations. But this method is liable to objection, on account of its altering the length of the balance-spring, and is besides very difficult to adjust. This Mr. Harrison seemed sensible of by observing, that the most perfect adjustment would be one in the balance itself, if it could be effected. This desideratum was effected by Peter Le Roy, at Paris, in 1766: he fixed two thermometer tubes, one at each side of the axis of the balance, which was placed perpendicularly; these were bent into the form of a parallelogram, projecting in the plane of the radius; the bulbs were at the top, near the axis, and the tubes proceeded from them directly outwards, then downwards, for a certain extent, and then returned again to the axis, along which they ascended, above the level of the bulbs. The lower part of the tubes contained mercury, the bulbs contained spirit of wine, and the ascending part of the tubes above the mercury were open at their ends. By this contrivance, on an increase of heat, the mercury was forced nearer the centre of motion by the expansion of the spirits, and on an excess of cold, the mercury moved towards the exterior branch, and the weight towards the circumference became greater, by which the alterations of the balance, by the same causes, were compensated.

Le Roy also executed the sort of compensation for the balance desired by Harrison, and employed Harrison's metallic thermometer for regulating the balance-spring for this purpose: he formed two semiperipheries, composed in the same manner of thin laminæ of brass and steel, with the brass outside; these were fastened by their middle parts to two opposite radii of the balance, and their extremities approaching nearer the centre, in hot weather, and passing farther from it in cold weather, formed a counterbalance to the effects of change of temperature on the spring, and other parts of the balance. The effect could be increased or diminished at pleasure, by putting more or less weight at the extremities of the same circular compensation pieces; where little balls of metal were placed for this purpose. Le Roy found this method to succeed well, but preferred his mercurial thermometer to it: our author, however, thinks the other decidedly superior for portable timekeepers, which opinion its great merit, on repeated trials, justifies.

In England Mr. Arnold generally passes for the author of this last metallic compensation, as he took a patent for it in 1782. It would be difficult to find an instance of a second inventor, if Mr. Arnold can be allowed that title, having obtained so much credit as he has done for a contrivance, the first author of which can be so clearly ascertained: most of the compensations applied

at present to the best chronometers are, as well as that called Arnold's, essentially the same as that published so long ago by P. Le Roy.

If a regulator vibrating in a free situation should be even perfectly isochronal, this advantage would be diminished or lost, when it was connected with a train of wheels. This consideration suggested the advantage of a regulator detached from the train, except at the short intervals necessary to give it a new impulse: and an ingenious contrivance for this purpose was executed by P. Le Roy also, in 1748, and a model of it presented to the Academy of Sciences at Paris.

To form this escapement, a curved pallet is affixed to the axis under the balance; and on the same axis, but above the balance, and beneath the spiral spring, is attached a semicylindrical piece, rounded off at the end, which acts on one arm of a detent, in the form of a joiner's square, moveable on a pivot at its angle, the end of the other arm of which, when moved forward by the action of the semicylinder, comes in contact with one of the teeth of the escape wheel, and stops its motion; after which the balance moves forward free of the train (the semicylindrical piece being so placed that it no longer touches the detent, after the latter has locked the escape-wheel), till it is overpowered by the resistance of the spiral spring, which then, re-acting on it, forces it back with an accelerated velocity, which near the end of its course impels the pallet against another tooth of the escape-wheel, and forces it back about the breadth of half a tooth: this leaving the detent at liberty, it is pressed back out of the way of the teeth of the escape-wheel by a straight spring acting against one of its arms, till it comes in contact with a stop. The escape-wheel being now disengaged, its tooth in contact with the pallet (by which it was moved backwards), re-acts on the pallet, and forces it back again along with the balance in the first direction: this again brings the semicylindrical piece into contact with the detent, and stops the escape-wheel, as before described, and the vibrations alternately repeat the above effects.

In 1766 Le Roy presented another detached escapement to the Academy, which he considered superior to the former. The action of this was contrived to take place on the circumference of the balance-wheel, by which the re-action on the pivots, which took place in the other construction, was prevented: it occasioned no recoil to the escape-wheel, and was besides formed to act without a spring, the use of which latter Le Roy thought occasioned considerable disadvantage, because, if it were too weak, its action was uncertain, and if it were strong, it caused a loss of power.

The parts of this detent were made as light as possible, that they might cause the least loss of motion to the balance, in locking and unlocking it; the escape-wheel was made with each

tooth forming a distinct radius, very light and far asunder, there being only six on the whole wheel. The detent consisted of four arms, two of which alternately locked the escape-wheel, and the two other, at different sides of the balance, were in their turn acted on by it, one at the forward vibration, and the other at the returning vibration; which action caused the disengagement of the arm that locked the escape, and brought the other arm into the position for stopping the next advancing tooth; the forward vibration of the balance brought the detent and escape into a position which Le Roy called the preparation, because it prepared them so as to admit the action of the escape on the balance in the returning vibration; when, on its unlocking the escape, one of the teeth acted on a pallet placed near the circumference of the balance, and impelled it forward, till the other arm of the detent came in contact with the tooth next it.

To prevent the detent being displaced by the effect of the circular motion, a circular curb was adapted to the circumference of the balance, near each pin which disengaged the detent, so that the arms of the detent could only touch the corresponding curbs by the most violent shakes.

From those two preceding escapements of Le Roy are derived all the detached escapements since executed, without any material improvement, unless the spring detent should be reckoned one.

The author does not think that Berthoud has with propriety classed Mudge's escapements among the detached, Mudge himself having declared the contrary: the mechanism of Mudge's contrivance consists of a kind of double remontoir, placed beyond the whole train, the two springs of which, alternately wound up and unlocked, act in constant succession on the balance.

The author agrees in opinion with Berthoud, that this construction is too complex, and requires too nice an execution ever to become generally useful.

Berthoud had laid claim to share the honour of the invention of the detached escapement with Le Roy; but the author shows very clearly that he had no just pretensions whatsoever to do so, and that Le Roy's title to priority cannot be invalidated.

Of the detached escapements published by Berthoud, which differ only in their detents, that which has been most generally used differs only from the first construction of Le Roy, in causing no recoil to the escape-wheel; having, like it, a detent moving on pivots, and pressed by a spring.

The construction which Berthoud thinks simplest and safest has an unlocking spring, which yields in one vibration, and releases the detent in the next; the other parts are similar to the first of Le Roy.

The second construction of Le Roy has not been followed by

Berthoud or by succeeding watch-makers, for which no reasons are stated in this history: in that adopted by Berthoud, the impulse of the escape-wheel is communicated to the balance, not on the circumference of the balance, as in Le Roy's, but on a pallet situated in a circle much nearer the axis: the detent also acts by springs; if, therefore, Le Roy's second method was an improvement, the art has been since retrograde in those two steps.

The construction contrived by Arnold, presented by his son to the Board of Longitude, differs principally from the French escapements, in having the joint of the detent formed by a spring instead of by pivots, which spring also supplies the place of the spring in the other constructions, that keeps the detent in its proper situation. The locking pallet is fastened to this spring; and another spring, made very delicate, runs along the back of the former, and projects a little beyond it: against this fine spring the discharging pallet, which is placed near the axis of the balance, acts; in one vibration this fine spring yields to the action of the discharging pallet, and lets it pass; but in the returning vibration, it is stopped from yielding by the back of the locking spring, and the pallet forces both springs down together, and thereby releases the tooth of the escape-wheel from the locking piece; the escape-wheel then communicates a fresh impulse to the balance by the action of one of its teeth on another pallet fixed in the edge of a circular piece attached to the axis of the balance, and concentrical with it, but which pallet is farther from the axis than the unlocking pallet: when this is done, the unlocking pallet has passed beyond the end of the springs has released them, and the action of the larger spring forces the locking pallet, attached to it, upwards, against an adjusting screw, so as to intercept the next tooth of the escape-wheel.

Earnshaw's escapement, presented also to the Board of Longitude, is precisely on the same principle as the former; and only differs from it in the shape of the teeth of the escape-wheel, which in Earnshaw's press against the pallet of the balance by a sharp angle, but in Arnold's by a cycloidal surface; therefore in Earnshaw's the action must be rougher, the friction more, and the wear greater.

The author of this paper has not positively decided as to the priority of invention of those two artists of the spring detent, but seems inclined to give it to Arnold, to whom he says, the priority of its publication is due.

The pivots of the old detent were so fine as to occasion but little friction; some therefore think the spring detent is chiefly preferable, on account of its facility of execution and cheapness: and the author thinks these advantages sufficient to entitle it to the

character of an improvement: it certainly is also superior to the other in simplicity of mechanism and in durability.

A little after the invention of the detached escapement, the isochronism of the vibrations of the spiral balance-spring were, if not discovered, at least perfected, and brought into general notice: the author thinks Hook's claim to this discovery doubtful; and the principle was so little attended to, that Harrison endeavoured to accomplish the same object by the form of the back of the pallets, and afterwards by adding a cycloidal pin to regulate the balance.

Le Roy was the first who distinctly published the discovery of a general principle proper to produce isochronism by means of the spiral spring, which he did in his *Memoire sur le meilleure Maniere de mesurer le Temps en Mer*, in 1766. Berthoud's investigations of this subject have been of great use, though he certainly has no just claim to dispute the invention with Le Roy; he however discovered the law which determined the isochronism of a spiral spring, that to possess this quality the spring must have an ascending force in arithmetical progression; and that this property may be effected not only by the length of the spring, but by the number of coils, and by decreasing its thickness from the centre to the extremity.

The application of the helical, or cylindrical spring, to the balance is attributed by the author to Mr. Arnold; but though its superiority, in producing isochronism, over the spiral spring, is very doubtful, yet as all manufacturers agree that it is more easily managed, he thinks it should be considered as a practical improvement.

Some have supposed that springs gradually lose their strength, and some remedies for this defect were proposed by Earnshaw that were as doubtful as the fact itself.

Among the great advantages of the isochronism of the balance-spring is the facility which it affords to procure wide vibrations, and increase the power of the regulator: another great advantage of it combined with the detached escapement, is the destruction of those variations which arise from the main spring, which is so effectual, that Le Roy in 1766 made watches which performed with great accuracy, without the fusee and chain, and in which consequently the force of the main spring acted immediately on the train of wheels. The late Mr. Arnold also tried the same construction with equal success.

The author concludes with stating his account of the progress of chronometry to be candid though not minute: the methods which do not admit of philosophical description, or have not been established by experiment, he does not consider within his limits, and places in the same class mere improvements in workmanship; though he thinks the leading principles, by which the

longitude is found at sea by mechanical means, have derived a very considerable part of their perfection from the excellency of the workmanship of chronometers.

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*Observations.*—The preceding paper will be read with interest by those who are any way concerned in the manufacture or performance of chronometers, as it presents at once a clear and comprehensive review of all that is generally known concerning the invention, application, properties, and improvements of them.

Some have attempted to make the wide and narrow vibrations of the pendulum or balance-spring isochronous, by tapering it at its outer end; others have tapered its inner end; and both methods have succeeded to a certain extent: others have succeeded equally well by increasing the length of the spring, and having found a length that was isochronous, have observed that to further extend or to diminish its length would destroy that property; but this is not strictly true in all circumstances, because we know, upon authority on which we place much reliance, that you may shorten or lengthen a spring without at all disturbing its isochronism, by only restoring the number of coils; and if an uniform spring be coiled into from eight to eight and one quarter coils, whatever may be the length, it will be isochronal. By this means we have been credibly informed that eight-day watches constructed without fusees have performed well, notwithstanding the maintaining power was continually diminishing from the time of winding up; and a movement, where the maintaining power was varied from 40 to 140 ounces, kept the same rate for several weeks. This circumstance we believe has never been before noticed; and we are authorized to say that the particulars of the experiments on which the above fact is established will shortly be made public by the discoverer in an early number of the Repertory of Arts, &c.

We should also notice that by the preceding paper it appears that the construction of Le Roy's, in which the chain and fusee were laid aside, affords a facility of obtaining the advantage gained by the going fusee in a very simple manner; for if the winding-up was performed by turning round the axis in the centre of the main spring, instead of by giving motion to the box in which it is contained, it is evident that the action of the main spring would not be at all interrupted during the operation; and it is obvious that the arrangement of parts necessary for this purpose could be very easily effected.

*Account of Mr.* Watkins's *Method of diminishing Friction in the Escapements of Timekeepers.—Trans. Soc. of Arts, Vol.* xxiii.

In timekeepers of the usual construction, the balance moves on a centre placed beyond the limits of the escape-wheel: hence the pallet of one and a tooth of the other coming into contact, have a friction in a direction towards their centres, till they come into a straight line with them, and, on leaving this position, have a friction in the opposite direction, till they cease to touch; Mr. Watkins's contrivance is intended to diminish the friction caused in this manner; it appeared evident to him, that if the escape and balance wheels could be made concentrical, the above friction would be entirely avoided; but as he found it impossible to do this completely without introducing other pieces, which would counteract the good effect of the arrangement, he supposed that by a judicious approximation to this position, much advantage might be gained.

In this construction, accordingly, the centre of the balance-wheel lies in or over the escape-wheel, so that the part of the balance which comes in contact with the escape-wheel moves in a circle internal to the circumference of the latter, whereby the friction is proportionally diminished. In the escapements which Mr. Watkins has hitherto made, the centre of the balance lies half way between the centre and the circumference of the escape-wheel, which latter has its teeth perpendicular to its plane, to receive the pallet of the balance which moves above that plane.

The detent of Mr. Watkins's balance is the spring detent invented by Mr. Arnold (described in the foregoing paper), with some small alteration of the position of the discharging spring, to fit it for the new arrangement of the other parts: this spring forms an angle with the locking spring, proportional to the distance of the discharging pallet from the outer edge of the escape-wheel; and a perpendicular arm runs from the head of the locking spring across this space, against the top of which the discharging spring presses, when impelled in that direction by the discharging pallet. An adjusting screw, to regulate the locking of the escape, is placed in the usual position, and the other parts do not materially differ from those of other constructions.

The Society of Arts voted thirty guineas to Mr. Watkins for this improvement.

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*Observations.*—The only advantage pretended to here is to lessen the friction between the wheel and the pallet during their time of action. If this end be answered at all, it can only be in a very small degree; for the friction is but little either in Mr. Arnold

or Mr. Earnshaw's escapements; and as the latter in particular uses much larger pallets (in proportion to the wheel) than can possibly be applied in Mr. W.'s method, any advantage is left doubtful; while the inconvenience in the construction, the disproportional size and increased weight of the wheel, are very serious objections; and for this plain reason, a wheel may be so far increased in diameter or in weight, or in both together, as to prevent its acquiring a velocity equal to that of the pallet at the time the wheel ought to act upon it: in that case the wheel would indeed follow the pallet, but could not act upon it; and although the weight and size may seldom or never be carried to this extreme, yet we soon arrive at a point where the impulse will be very much diminished, more particularly in high trains, which are mostly made use of in chronometers, for reasons too obvious to need our insisting upon them here.

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## *Description of Mr.* Hardy's *Compensation Balance for Timekeepers.—Trans. Soc. of Arts, Vol.* xxiii.

Mr. Hardy's compensation is effected by the direct expansion of the metals of which it is composed. In that in most general use (which was first executed by the celebrated P. Le Roy, on the principle of Harrison's expansion curb), two laminæ of brass and steel, soldered together, form the circumference of a circular balance; which being divided in two or more places, leave the extremities moveable by the alteration of temperature: near these extremities sliding weights are placed to regulate the effects of the balance. Mr. Hardy's balance differs from this in shape as well as in its properties. Instead of the circular piece usual, a flat steel bar is attached to the axis by its centre; near its extremities it is cut thin enough to act as a spring; and just beyond these springs, small stems cross it at right angles in the plane of the axis, which stems are also made of the same piece as the bar. The part of the stem below the bar projects but little, but the part above projects nearly equal to half the length of the balance-bar; by which means the stems form a sort of levers moveable on the springs as on a centre, having a short arm below, and a longer arm above the bar. Beneath the balance-bar are placed two small brass rods: one of these rods is secured at one end by a stud, formed out of the substance of the balance-bar, while its other end acts on the short lever of one of the stems: the other metallic rod, secured in the same manner at its opposite end, acts against the other stem. On the longer arm of each of these stems a small globe of brass is made to slide or screw, so as to be raised or lowered as required. A screw also passes through each stem in the direction of the balance-bar, to regulate to mean time by its weight.

The length of the steel balance-bar is—1.600, its breadth 0.232, and its thickness 0.032. The length of each of the brass compensation-rods is 1.470, its breadth 0.078, and its thickness 0.032. The length of each of the two springs formed out of the steel bar is 0.030; the length of the perpendicular stems, as represented in the plate, about 0.8; and the diameter of each of the small brass globes about a quarter of an inch.

When the whole balance is heated, the superior expansion of the brass rods will, by pressing against the short arms of the stems, cause the longer arms along with the globes to incline towards the centre, and thereby throw the weight inwards, in the same proportion, wherein the long arm exceeds the short arm of each stem in length: thus, if the short arm be to the long arm as 1 to 20, then it is evident the motion of the globe inwards will be twenty times the excess of the expansion of the brass rods above that of the steel bar.

To increase the effect of the compensating bars, the globes should be moved higher up on the stems, and to diminish it the reverse should be performed.

The chief advantages of Mr. Hardy's invention, as stated by Mr. W. Nicholson, in a letter to the Society of Arts, are—

1st, The steady effect produced confines the flexure of the steel bar to a small part near its extremities.

2dly, The facility of the construction.

3dly, As the contrivance has neither joints nor working surfaces, it will regularly obey the changes of temperature, and not act by jerks or starts.

4thly, It is free from the defects of the common compensation, whose action tends to destroy the form of its parts, by the stronger piece of it extending or contracting the weaker beyond its natural power of recovery; hence it will be more durable and more uniform in its effects.

5thly, The adjustment for temperature being made in lines nearly parallel to the axis or verge, will have no practical effect, in deranging the adjustment for position.

A premium of thirty guineas was given Mr. Hardy by the Society of Arts, &c. for this invention.

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*Observations.*—Notwithstanding Mr. Hardy's well-known abilities and the high testimonies of approbation he has obtained, we still entertain doubts whether a balance so constructed is in any respect better than others, as they are now commonly made, while we fear that in one particular it will prove worse: we apprehend it is not within the limits of human industry to manufacture pieces of such small dimensions with that degree of accuracy necessary to cause the balls to move in the planes described in his paper, even as to sense, much less mathematically and physically; we think the brass bars should have acted merely by

expansion, and should not have admitted of any flexure whatever (as Mr. Nicholson in his observations in commendation of this invention says), we are apprehensive that on that as well as on other accounts, the centrifugal force will have as great and as bad an effect on a balance of this construction as on any other.

Another defect apparent in this balance is, that it will be liable to some alteration when its axis and stems are held in an horizontal plane; for then the brass weights at the end of the stems pressing downwards, will (from the springs at the ends of the bar yielding to the twisting motion this will cause in them) fall somewhat below the true plane of the axis; the same effect will also take place in some degree when the axis is vertical, from the momentum of the balls, at the end of each vibration, causing them to pass onward, after the motion of the steel balance-bar has been stopped by the resistance of the spiral spring, which motion the same yielding of the springs of the bar will permit.

We conceive it is no small objection to expansion balances of every construction that they have irregularly projecting parts, such as weights, screws, arms, &c. on account of the resistance of the air, which, though its thermometrical effects may be compensated, yet there is no provision against the barometrical effects: in this respect Mr. Hardy's construction is the worst. We also think that steel should not be used at all in the construction of balances, for it has been known to acquire so strong a polarity as to make twelve minutes per day difference in the rate of a watch by only changing the position of it from one, where the north pole of the balance (when at rest) was directed towards the magnetic north, or *vice versa*. For a fuller account of this interesting fact we refer to the first volume of the Philosophical Magazine.

We have only one observation more to make—Mr. Harrison, in his first attempts (which were unsuccessful), employed bars with balls on their ends for his balances, but in his later and more successful attempts he used common balances. The author of these remarks has seen Mr. Harrison's first timepieces repeatedly at the Royal Observatory, Greenwich, where probably they may still remain. This clears up the point left undecided by the author of the preceding historical account of chronometers, page 301, &c.

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*Method proposed by Mr.* HARDY *for rendering the Vibrations of the Balance of a Timekeeper equal*—*Phil. Jour.* No. 59.

IN the figure which accompanies the original paper, the balance is represented with a cylindrical or screw spring, the vibrations of which Mr. Hardy supposes may be rendered equal by the addition of another spring somewhat weaker, to which the extremity

of the first spring, farthest from the balance, is attached, and which passes nearly across the diameter of the balance, and is straight throughout except where it passes the verge, in which place it is a little curved: this secondary spring is a little longer than the diameter of the coils of the first spring, and is screwed to the plate at the farthest extremity from the point of juncture with the first, beyond which point it projects a little so as to pass on into a groove, or fork, cut in a small piece of brass projecting from the plate; at each side of this fork is fixed an adjusting screw pointing towards the head of the spring, by which its space of free motion can be regulated as required.

Mr. Hardy's reasoning on this construction is as follows:

As this secondary spring is weaker than the balance-spring, it will be first brought into action; but on being stopped by the adjusting screws its action will cease and that of the balance-spring commence, and consequently progressively accelerate the vibrations of the balance. It will therefore always oppose the accelerating effects of the wheel in the short vibrations, and so cause the whole of them to be performed nearly in the same time.

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*Observation.*—If the assertion published first by the celebrated Le Roy, and since assented to by other eminent authorities, be true, "that there is in every spring of a sufficient extent a certain length where all the vibrations, great and small, are isochronous;" it does not appear that a secondary spring is of any absolute advantage, unless it were either impossible or extremely difficult to ascertain that precise length of the spring mentioned by Le Roy. But it will be unnecessary to dwell longer upon this point after what has been said at page 309.

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## *Account of Mr.* Ward's *improved striking Part of a Clock.*—*Trans. Soc. Arts, Vol* xxiii.

The minute wheel, hour wheel, bridge, and snail, are the same as in a common clock. The power to draw the hammer is obtained from the acquired momentum of the pendulum itself, and the striking the hours is effected as follows: The hammer arbour is brought through the dial-plate of the movement, and its pivot runs in a small cock sufficiently high to admit the tail of the hammer to be put at such convenient distance above the plate as to fall into the teeth of the rack like the hook of a common clock, which being necessarily lifted up every time the gathering pallet draws the rack a tooth forward, in returning the hammer is made to strike the bell: in like manner the pallet arbour is brought through the same plate to admit an arm of brass, which being firmly fixed upon it, must vibrate with the pallets and pendulum;

at the other extremity of this arm is planted a small stud to receive the gathering pallet, which by means of a snap spring can be retained in a situation either to act upon the rack in such a manner as to move it forward one tooth at every other vibration of the pendulum in the time of striking, or when the number of hours are struck, so as to miss the teeth of the rack, and permit the pendulum to vibrate freely as in common: a pin is fixed in the back of the minute-wheel, which, as it revolves, raises a lever by which the hammer tail is lifted out of the rack, which is then at liberty to fall: the lever still bearing upon this pin, returns gradually, and prevents the hammer from striking the bell; this done, another pin in the front side of the same wheel lifts a flirt, and at the proper time lets it fall upon the gathering pallet, which puts it into a situation to draw the rack, and when the number of hours is struck, a pin in the rack is brought forward so as to press against a part of the gathering pallet, which forcing it into its second situation, the pendulum continues to vibrate as before.

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*Observations.*—The simplicity and good disposition of the parts, which are all calculated and arranged so as to act well, reflects no small degree of credit to the inventor. The only objection which occurs to us (besides the one Mr. Ward himself has noticed), is to the weight necessary to give sufficient momentum to the pendulum to raise the hammer with the requisite force to strike a blow loud enough to be well heard in the different parts of a house, and the unavoidable wear occasioned by so large a maintaining power. Mr. Ward made his experiment with a pendulum weighing nearly nine pounds, and a weight of twenty-four pounds; this is twice as much as would keep a much heavier pendulum going for a whole month, and yet we think would only produce a feeble blow.

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*Account of the Invention of the Balance-spring, &c. together with various other historical Details relative to Timepieces. By Mr.* Thomas Reid.—*Phil. Jour.* No. 59.

Some of the information contained in this account, is a recital of facts similar to those stated in another paper inserted at page 301, &c. of the present number.

Mr. Reid begins his letter with documents to prove Dr. Hooke the original inventor of the pendulum spring, and of its properties; and that the claim of Huyghens to the discovery is unfounded.

He then mentions that Galileo, before the year 1642, had given an account of the equality of the wide and narrow vibrations of the pendulum, and recommended it to astronomers in preference

to the balance which they were then attemping to use in their observatories.

Next follow some historical details relative to Dr. Hooke, his first introduction at Oxford, his great mechanical abilities and discoveries, his systems for inventions called by him *algebras*, his approximation to the discovery of the properties of the cycloid, which about eight years afterwards were so fully investigated by Huyghens, who about the year 1657 presented his first clock to the States of Holland.

Hooke in 1658 is stated to have discovered the isochronism of springs, to have made watches on that principle, and to have got a patent for the invention, in conjunction with Sir Robert Murray and Mr. Boyle, who were to endeavour to procure an act for levying a groat per ton on all ships sailing from England, in reward for the discovery, in the profits of which they were to share; but which connexion was afterwards ended by a disagreement between the parties, in which Dr. Hooke appears to have been used unhandsomely. It is evident that he published his discoveries in 1660, from a registry of the Royal Society, which records that Mr. Hooke had exhibited his *pocket* watches, which were *regulated* by *springs*.

Hooke is also stated as the first inventor of the revolving pendulum, usually attributed to Huyghens; one of his contrivance was exhibited in Oxford in 1657, which is said not to have answered his expectations. It consisted of two balls exactly balanced on either end of a rod of metal, the centre of which was supported by a pivot in the midst of a revolving axis, by which means it had a free motion in the plane of the axis; a spiral spring passing from the centre of the librating rod to the side of the revolving axis, tended to keep the rod in a perpendicular position, in opposition to the centrifugal force of the balls (when the axis was turned round), which tended to render the rod horizontal. The spring was tapered, in order to produce an isochronous circulation, and its force was intended to supply the action which gravity has in those of the construction adopted by Huyghens.

An account next follows, of lectures given at Gresham college by Dr. Hooke, on the application of springs to the regulation of timekeepers, extracted from a work published by the Doctor in 1676, on *Helioscopes and some other instruments*. In these lectures he explained above TWENTY SEVERAL WAYS in which springs might be applied to the above purpose, and how THE VIBRATIONS MIGHT BE SO REGULATED as to make their durations all *equal*, or the greater QUICKER or SLOWER than the less, in any proportion assigned. All which particulars were also exhibited before the Royal Society.

In 1678 Dr. Hooke published his *Potentia restituta*, or Spring; and about two years before gave the theory of this force at the end of his book on *Helioscopes*, in an anagram, which formed the

words *Ut tensio sic vis.* Dr. Hooke in the above work described his instrument for proving the isochronism of the *flat and the cylindrical helix,* which differed little from an instrument afterwards invented by Berthoud, which he called the *elastic balance.*

In 1770 the author mentions that Le Roy observed the properties on which the isochronism of springs depended, which is about 100 years after Hooke had noticed their use.

There next follows a long detail of the controversy between Le Roy and Berthoud respecting the priority of their discoveries relative to spiral springs and free escapements; but the respective merits of these gentlemen having been in these points already fully investigated in another paper in this number, it would be needless to repeat the same facts here, even if our limits allowed us to enter more at large on the subject.

The author next states his opinion, that not only the idea of the thermometrical compensation for balances was taken from Harrison's compensation-bars, by Le Roy (which the latter himself admitted), but endeavours to prove that the invention of the compensation-balance is due also to Harrison, by a quotation from a letter of Mr. Mudge, which mentions that Harrison attempted to make the compensation in the balance, but not liking the performance of his machinery, or not finding it to answer, threw it away.

Some remarks next succeed relative to Mr. Arnold, which are similar to those in the former paper.

The author states that the reason for Hooke's not having published an account of his inventions and theory relative to springs (about which matters so much has since been written), was, that, directly after the great fire in London in 1666, he was employed in surveying the waste ground left by the fire, and in arranging the different claims to it, which he probably found more profitable than the business of his longitude watches.

The author mentions in a postscript to his letter, that in a work published by Thiout in 1741, among a large collection of the various escapements then known, there is one, apparently invented by himself, *which seems a sort of free or detached one,* which he thinks the same in its principle as the one invented by Le Roy in 1748, and wonders that he and Berthoud overlooked it in their dispute for priority of invention.

This escapement consists of a detent with two arms, the end of one of which locks on the teeth of the escape-wheel; the extremity of the other arm is formed into a small fork, in which a piece projecting from the axis of the balance works; a pallet is also attached to the same axis on which the teeth of the escape-wheel operate to impel the balance; the pallet is intended to come within the action of the teeth, at the same time that the projecting piece pressing on the fork raises the other arm and disengages the detent, at which instant the teeth of the escape-

wheel are to impel the pallet in the opposite direction, and the projecting piece to press the fork the reverse way and lock the detent: on the returning vibration the same operation is to be repeated.

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*Observation.*—Either the figure given in the Philosophical Journal of this last escapement must be erroneous, or Mr. Reid be mistaken as to the operation of the contrivance; for in an apparatus made like the figure, the motion of the balance would be entirely stopped by the fork a little after the detent had locked the escape.

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*On measuring a Ship's Velocity. By Mr.* H. Hamill, *jun.—Phil. Jour.* No. 58.

Mr. Hamill proposes a variation in the use of an instrument for measuring a ship's way, which he states, on the authority of Gregory's Mechanics, to have been the contrivance of M. Pitot. The instrument consists of two tubes, one with a trumpet mouth turned forwards to face the impulse of the water, the other rising vertically from the bottom. The difference of the height of water in these two tubes it was supposed would denote the velocity of the ship.

Mr. Hamill observes that the fluctuation of the sea would render the rise of the water in the tubes undulatory and irregular, and to remedy this defect, proposes that the orifice of the trumpet tube within the ship shall be on a level with the water, and have a receiver annexed to it to catch the water, which will run over from it when the ship is under way; by the quantity of the water flowing into the receiver in a given time, and through a given aperture, Mr. Hamill supposes the velocity of the vessel may be better ascertained than by the method of M. Pitot.

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*Observations.*—Mr. Francis Hopkinson of Philadelphia as well as M. Pitot claims the invention of this contrivance. In the third volume of the American Philosophical Transactions, published before the termination of the past century, a similar instrument to that mentioned above is described by that gentleman, but without a trumpet head or secondary tube.

Captain Hamilton (now Commissioner of the Navy) also reinvented this instrument in 1802; he has published an account of his contrivance in the Repertory of Arts for October of that year, differing from the others merely in its being placed near the centre of the ship, and which Pitot recommended, and having the external aperture in the fore part of a perpendicular pipe closed at its extremity, and projecting about five inches beyond the bottom.

The height of the water in these tubes will depend on that of the external water, and on the *obliquity* of the aperture to the

impulse of the water, as well as on the velocity of that impulse. Every wave that the ship passes must therefore affect the elevation of the water in the tube, and this very irregularly, as it would require *some time* to convey the effect through the tube.

In Captain Hamilton's tube the velocity of the impulse would be in a great measure lost against the opposite side of the tube by its vertical position. The others (where this defect is removed by the gradual flexure of the pipes from a horizontal to a perpendicular position), as well as his, are merely calculated to operate when sailing before the wind; when sailing with a side wind, the impulse of the water on the external aperture would be *oblique*; and this, according to Venturi's accurate experiments, would produce variations so great, as in some cases even to cause the water to descend in the tubes when those gentlemen would expect it to rise.

The degree of overflow of the water proposed by Mr. Hamill, would be subject to all the inaccuracies of its rise and fall in the other methods: and as, for the reasons stated, we do not hesitate to assert, that no accurate instrument for measuring a ship's way can be made on these principles, so his alteration of what is bad essentially cannot be an improvement.

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*Observations on Squalls, and on the Cause of a Swell of the Sea preceding a Storm. By* W. N.—*Phil. Jour.* No. 57.

The cause of squalls at sea is, according to the opinion of the author, the action of rain in its descent, which operating on the air in a manner similar to the expanded fall of water in an hydraulic blowing-engine, produces an aerial current at first directly downwards, and then in various directions according to the angle in which it is deflected by the sea.

The cloud which affords the descending rain is generally moved along by the common wind, or lower current of the atmosphere; and the stream of descending water is in all cases affected with the same horizontal motion; hence the squall possesses both the velocity of the falling water (which is greatest at the place of descent, and diminishes in receding from that place), and the velocity of the cloud, or blowing apparatus, which is the same as that of the prevailing wind, or horizontal current of air. The first of these velocities constitutes a storm, within its limited sphere of activity, and the other velocity measures the progress with which the storm is horizontally conveyed along. The descending current of air will cause a depression in the water beneath it, and a proportional rise in a more distant part, which will proceed onwards in all directions in a succession of waves, similar to those caused on a small scale by throwing a stone into smooth water, and thus constitute a *swell of the sea*; which moving onwards uniformly at a certain distance from the place of greatest storm,

will be alone modified by the common wind, which it will either outrun, follow, or cross, according to circumstances, nothing being more common at sea than to have the wind in one direction and the swell in another.

The author supposes that all storms are produced in the same manner as squalls, by descending currents from the upper part of the atmosphere, caused in some instances by the fall of great masses of water, and in others by chemical causes, concerning which we scarcely dare to form a conjecture.

The white squall, or squall without rain, and the typhon of the Chinese seas, which last continues for twelve or eighteen hours, comes on suddenly, and blows with extreme violence from every point of the compass in succession. The limited streams of air which have been known to rush across the face of a country, marked by a narrow line of devastation, whirlwinds, waterspouts, explosive noises, and the great agitation of the atmosphere which so often accompanies the fall of ignited stones from the higher regions, all shew that the air may be put into violent motion by other causes, as well as its change of elasticity from heat and cold, and the mechanical action of descending water.

Whatever great and powerful agent may cause the descending current of air which throws the sea into a swell, the swell will proceed till its velocity and motion is gradually lost in distant waters, while the centre of action, or the squall, may either be stationary, or move along with any determinate degree of velocity. From the nature of the case its motion will either coincide with or follow that of the swell it causes.

Whenever a heavy swell arrives upon any coast, it will, according to the doctrine here laid down, indicate that a storm or long-continued squall has existed, and probably continues to exist, towards that point of the compass from which the swell arrives: if its progressive velocity and duration be sufficient, the storm will arrive at the coast subsequent to the swell, unless its first generation or commencement was near shore; but it often happens that the atmospheric cause of the swell may have ceased long before the swell itself has subsided.

These remarks of Mr. Nicholson were occasioned by a letter to him, inquiring the reason why a swell of the sea often precedes a storm.

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*Observations.*—That *all* storms are caused in the same manner as squalls, as above stated, seems an inference by much more general than facts as yet known can warrant.

The author having conjectured that other causes may exist for sudden storms besides those he has recited; it is presumed that the mention of one of this nature, the possibility of which has occurred to the compiler of this article, may not be unacceptable.

A sudden action of a great body of electric fire, or lightning,

on a cloud, or collection of water in a state of vapour, will, in many cases, decompose a large part of the water into its constituent gases, which may, by attraction, adhere to the undissipated part of the cloud, till they exist in a considerably extensive volume: another discharge of electric fire may explode these gases; this will first cause a great expansion of the air from the great rarefaction by heat of the remaining water of the cloud, and immediately afterwards a rapid contraction of its volume will take place, which will approximate to a vacuum, into which the surrounding air rushing from every side will cause a wind from below upwards (the reverse of that constituting a squall), and other winds from various points of the compass, at the surface of the globe, to supply the ascending current. It is possible also that water-spouts may take place from a similar cause; the rising of the sea towards the cloud, generally observed in this phenomenon, seems to indicate the point of an ascending current, to which the air rushing from every side would naturally force the water, and thereby cause an accumulation in a particular spot. The sudden increase of clouds also in thunder-storms, appears to prove the collection of vapours brought by various currents of air directed to one point.

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*On the Properties of tempered Steel. By* T. B. *of Sheffield.—Phil. Jour.* No. 57.

A PLATE of steel 30 inches long, 12 broad, and 4 thick, was hardened in a composition of oil and tallow, and afterwards tempered down to a spring temper; by hammering to set it straight it lost a part of its elasticity; and by grinding, as is usual for saws, the whole elasticity was nearly lost: on heating till it became blue, it recovered the whole of its elasticity; which was again somewhat impaired by glazing the plate bright on a glazier coated with emery, but in a less degree than when it was ground: the same effect was produced by rubbing with emery or sand paper, and also by burnishing; but the elasticity was invariably recovered by blueing, and hence this is always the last operation in the manufacture of elastic steel plate.

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*Description of an expanding Band-wheel to regulate the Velocity of Machinery. Invented by Mr.* ANDREW FLINT.—*Trans. Soc. of Arts, Vol.* xxiii.

To enable the artisan to regulate the velocity of his machinery at pleasure, the moving power remaining as before, or to retain the same motion with an alteration in that of the applied force, is the purpose of this invention. Two methods are proposed of accomplishing this: in both the periphery of the band-

wheel is divided into any convenient number of parts, according to the size of the wheels (in the case of Mr. Flint's model, twelve), which may be placed at any given distance from the centre of the wheel (within the limits of the machinery), and thus, by enlarging the circumference of one band-wheel, while the other is equally diminished, to alter the relative velocity of both at pleasure. Those parts of the periphery which Mr. Flint terms V's, are confined to move in grooves cut in the large wheels called A and B in the direction of their spokes or radii; and are moved by a spiral thread in a small wheel called C (moving on the same shaft as the wheel A), which thread takes into the teeth of the racks on which the V's are fixed. A part of the shaft on which the wheel A is fixed is made circular to allow the small wheel C to turn round independently of the other; and thus to extend and contract the racks and V's carrying the band. The wheel C is moved round the shaft by a pinion, on the axis of which a winch is occasionally fixed.

In the other contrivance for producing the same effect, there is a series of an *even* number of equal and similar screws, alternately right and left handed, disposed at equal distances in radii of the wheel, and as they turn moving nuts upon them (to carry the band) nearer to or farther from the centre. Equal bevel-wheels are fixed at the lower ends of the screws near the axis of the wheel, and these bevel-wheels play into one another all round. Any one of the screws may be turned by means of a winch applied to its projecting head, and then the bevel-wheels will communicate motion to the whole, and expand or contract the periphery of the rigger as required.—Fifty guineas were voted by the Society to Mr. Flint for this invention.

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*Observations.*—Both these contrivances are ingenious and well adapted to the purpose; but we prefer that by means of the alternate right and left handed screws, as easiest to keep in order, and furnishing the safest resistance against any pressure upon the wheel. These contrivances *may* have been suggested by considering Mr. R. Hall's method of varying the position of the bars in his *expanding crane*, rewarded likewise by the Society of Arts (see vol. xii. of their Transactions, Phil. Mag. vol. xviii. or Gregory's Mechanics, vol. ii.). But be this as it may, there is a sufficient distinction between the methods to leave Mr. Flint a due portion of credit and of commendation for his useful invention.

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*Description of several new and improved Tools applicable to Lathes, &c. By Mr.* J. I. Hawkins, *Dalby Terrace, City Road.—Rep. of Arts, &c.* No. 50, New Series.

The first of these contrivances is for what the workmen term a *wire chock:* it consists of three dies, each about three quarters

of an inch long, which are forced upon the wire by five screws the heads of three of which appear upon the exterior perimeter of the chock at distances of 120° from one another. Two of the dies have each two screws, one acting near each end; the other die only one screw, acting about its middle. Each die has a dove-tailed groove in its back to receive the ends of the screws, each of which terminates in an inverted conic frustrum; by these means a screw serves as well to draw its respective die backwards as to push it forwards towards the wire. The sharp edge of each die next the wire is taken off, that it may not indent the wire. This chock manifestly requires no particular accuracy in the construction, as it possesses, by means of the screws, the power of remedying the defects of bad workmanship. After the wire has been once adjusted, the turning of one screw will release it; and when that one screw forces its die on the wire, it is held firmly in every direction.

Mr. Hawkins has likewise described two useful tools in the making of metal screws, the inventor of which he does not know. One is a tool for making a conical point to a wire, which is made of a piece of round steel, by filing two deep notches in the end, crossing each other at right angles. This tool is either held in the hand and the wire fixed in the chock, or the tool put in the chock and the wire held by a hand-vice. The other tool is for making the cylindric body of a screw preparatory to tapping: it is made by drilling a hole in the end of a piece of steel, the size and depth of the screw required, and then cutting that part which surrounds the hole into teeth like a coarse file; if the shoulder of the screw be required square, the tool must be flat at the end; but if conical, it must be made of the same shape.

To save time in making of screws Mr. Hawkins has contrived to fix a die stock on the end of a small hollow mandril, fitted to a frame which could be put into the bench vice when wanted; it turns by a winch, and has a socket to receive taps on a mandril in another frame. By this contrivance four or five times as much work can be performed as in the common way.

The last tool described is one for making square or other shaped holes in metal plates: this tool is used in Philadelphia, and consists of a taper piece of steel made in the shape of the hole, with teeth cut obliquely across all its sides: these teeth are reversed alternately, to prevent the tool from having any tendency to twist when it is driven in by the hammer.

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*Observations.*—Most of these contrivances deserve the attention of those who are concerned in turning, or in the making of screws. More minute descriptions, illustrated by diagrams, may be seen in the number of the Repertory mentioned at the head of this article.

## *Count* Rumford's *Inquiries concerning the Mode of propagating Heat in Liquids.—Phil. Jour.* No. 59.

Count Rumford observes that great difference exists between the propagation of heat in solids and in fluids. In solids, it passes from particle to particle in succession, apparently with the same celerity in every direction; but heat in fluids is transmitted in a very different manner.

A solid hotter than a fluid, in which it is plunged, will heat the particles in contact, and render them lighter, by which they will rise to the surface in a continued current, and carry all the heat to it, so that the strata of the liquid situated at a small distance under the hot body, are not sensibly heated by it.

A body colder than the fluid which surrounds it, will, on the contrary, cool the liquor beneath it, without immediately reducing the temperature of that above it.

Heat is easily transmitted through a metallic plate, and but slowly through dry board; the first may with propriety therefore be called a good conductor, and the latter a bad conductor of heat; but as the conducting power of water depends on the above circumstances, the Count thinks his calling it a non-conductor is inaccurate, though for want of a more suitable term he is obliged to use it.

The difficulty with which heat is communicated through water, from its mobility, made the Count suppose that a direct passage of heat in this fluid was impossible; but further experience shewed him that, when the mobility of liquors is destroyed, they conduct heat, although very slowly.

That a hot body heats a fluid upwards is well known; but whether the strata of the fluid directly under the hot body *are heated by it, by means of a direct communication of heat from above downwards, from particle to particle, these particles remaining in their places,* is a question on which philosophers are not agreed. To determine this question by experiment, the Count contrived the following apparatus, by which he thinks the point has been accurately decided.

A tube of sheet brass, 6 inches long, and 1 inch in diameter, ending in a conical point, descends perpendicularly from the middle of the bottom of a cylindrical vessel, of the same substance, 3 inches diameter, and $2\frac{1}{2}$ inches high, which has a lateral spout placed a little above its bottom.

In the middle of this tube a smaller tube, $\frac{3}{10}$ of an inch in diameter, descends to near the bottom, where it is surrounded by a conical flanch, parallel to the conical termination of the external tube, placed so as to permit a narrow passage all round between both. To the upper part of this small internal tube

is added a funnel, that spreads at top to the extent of the cylindrical vessel above the external tube, into which it fits exactly, by which means it and the small tube are kept in their places.

A tube of wood 2 inches in diameter without, encloses the external brass tube, from the cylindrical vessel, to the end of the conical termination.

A wooden frame supports this apparatus vertically, so that the lower extremity of the wooden tube is plunged $\frac{6}{10}$ of an inch below the surface of the water contained in a large cylindrical vessel 10 inches diameter and $4\frac{1}{2}$ inches deep, placed beneath it. Another vessel of sheet brass surrounds the lower extremity of the wooden tube, 5 inches in diameter without, and about half the length of the wooden tube; it is perforated at its bottom to let the wooden tube pass, from which perforation an internal tube rises that encloses the wooden one closely; the whole forming an annular vessel, that holds water round the wooden tube $2\frac{1}{2}$ inches deep; this annular vessel is supported so that its bottom is a quarter of an inch beneath the surface of the water in the large vessel.

The wooden frame has two strong shelves moveable up and down on two stout pillars, and retained at the desired height by screws of compression; the upper shelf supports the tubes and their attendant parts; the lower shelf supports the annular vessel; both are perforated so as to let the vessels pass downwards in their proper positions.

At the bottom of the large water vessel, directly under the centre of the conical termination of the brass tube, is fixed a short vertical tube of tin, which serves as a support to a small hemispherical cup of wood 2 inches in diameter without, and half an inch thick; a stalk descending from the cup fits tightly into the thin tube, and sustains the brim of the cup, exactly $\frac{3}{10}$ of an inch below the bottom of the wooden tube.

A small mercurial thermometer of great sensibility, was sustained in the cup, by its tube and scale passing horizontally through the side of the latter, so that the lower part of its bulb was elevated a tenth of an inch above the bottom of the cup, and the upper part remained a tenth below the level of its brim. The diameter of the bulb was $\frac{3}{10}$ of an inch, and the depth of the cup half an inch.

By pouring boiling water into the funnel of the apparatus described, the hollow conical point of the brass tube will be nearly at the heat of boiling water. The water between this point and the end of the wooden tube, will soon become of the same heat, as no current can pass from it. Now, if heat passed through water downwards, it would no doubt pass from this hot water to that in the cup, only $\frac{1}{10}$ of an inch beneath it. But the thermometer in this cup remained at perfect rest during three experiments; in the

first of which the boiling water was poured into the funnel for ten minutes; in the second for twelve minutes; and in the third during fifteen minutes.

A small thermometer, placed in the annular vessel, shewed that the water in it had received a little heat in each of the experiments.

A similar thermometer placed in the water of the large vessel shewed, that it had not acquired any sensible increase of temperature during the time of trial.

These experiments determine that heat does not pass downwards in fluids free to circulate, but does not prove that fluids cannot conduct heat from particle to particle. The particles of water immediately below the wooden tube might have been heated, and have risen up to the surface, and their places been supplied by cold particles, which would prevent the heat from passing to the thermometer, by carrying off the descending heat.

The Count suspects the mobility of small masses of a liquid (if not of the primary particles) solely prevents the direct communication of heat between the neighbouring parts. He considers the force with which the particles adhere as very great, and from this circumstance accounts for the suspension of heavy bodies, which lighter liquids hold in solution.

From some experiments made to discover the viscosity of fluids, the Count found reason to conclude that a body having 368 square inches surface, and weighing only one grain more than the water, would remain suspended in it; from whence he calculates that a solid spherule of gold of $\frac{1}{300000}$ of an inch, ought to remain suspended in the water, in consequence of the adhesion of its particles.

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## *Mr.* John Sadler's *Account of the English Process for refining Lead.—Phil. Jour.* No. 60.

The object of refining lead is not merely on account of the silver it contains, but to obtain it as free from mixture with other metals as possible, and to procure litharge. The silver is only an object as it helps to pay the expenses of refining.

English lead is at first found always alloyed with a portion of silver, and with one or more of the following metals—zinc, antimony, copper, and arsenic, which render it unfit for the usual purposes of lead.

The process of refining is founded on the facility with which lead is oxidated, when exposed to heat in contact with air; and the readiness of fusion, and combination with most other metals, except with gold, silver, and platina, which its oxides possess.

The lead to be refined is exposed to the action of heat and air in a test, composed of a mixture of bone and fern ashes, in a reverberatory furnace; which differs but little from the common construction, except that the bottom is perforated to receive the test, or cupel.

This furnace contains an elliptical area, in which the test is fixed, at one side of which is the fire-place, and at the other the chimney; an arched dome gradually sloping downwards from above the fire, over the test to the chimney, directs the flame, in the usual way, to strike on the test.

At one end of the elliptical area is a hole, for admitting the nozzle of a bellows, just above the level of the test; at its other end is the aperture for putting in the lead on the test, before which is fixed a strong bar to sustain the handle of the ladle, by which it is conveyed; and at one side of it the iron pot, in which the lead is melted, is set in masonry: an arch is erected in front of it, with a flue to convey away the fumes of the lead.

Below the elliptical area strong iron bars run across, to sustain the test, which, when placed over them, is forced up into its place by wedges.

The whole is formed of good solid masonry, bound together with iron bars.

The test is contained in an elliptical rim of iron of its own depth, crossed at bottom by five flat iron bars parallel to each other; in this frame a mixture of six parts of bone ashes, and one of fern ashes, is well rammed up to the level of the top of the rim; an excavation is then scooped out of it, to contain the lead, with a sharp spade about five inches square; and a semi-elliptical hole is cut through it in front, to let the litharge flow down. The top of the rim is then plastered with clay, to make it join close to the projection of the area, against which it is then pressed up by wedges as before mentioned.

A gentle fire is first made to dry the test, and gradually increased, till the test is red hot. When it ceases to emit steam from the under side, it is sufficiently dry.

Lead melted in the iron pot is then ladled into the test till the hollow is nearly filled; the operator then closes the feeding aperture, and increases the heat of the furnace, till the lead is well covered with litharge; the feeding hole is then opened, and with an iron rod, bent at right angles about three inches at one end, he scrapes a small channel in the edge of the test, for the litharge to flow into the discharging aperture; the blast of a strong pair of bellows is then directed from the back part over the test, which urges the litharge forward to the channel, whence it flows down on the floor. More lead is then added as the litharge escapes, until the channel is worn down, so that the test contains but one inch depth of lead; the blast is then stopped, the channel filled

with moistened ashes, the test again filled with lead, though not so full as at first, and the operation is then carried on, till a second channel, made at a proper distance from the former, is worn down, and the test contains but from 50 to 70 lbs. of alloy, which is run into an iron pot, till enough is collected to make it worth while to take off a plate of silver from it; the method of doing which differs in no respect from the process described, but that more care is taken to prevent any particles of metal from escaping with the litharge, on account of its superior value.

As this last operation advances, the litharge assumes a darker colour, a greater heat becomes necessary, and at last the *brightening* takes place, when the interior of the furnace clears up, which before had been obscure and misty during the whole process. And when the surface of the silver is free from litharge, the blast is stopped, and the furnace permitted to cool gradually.

The litharge flakes in cooling; though it is in clots at first, it afterwards falls like slaked lime: the last portions of it which come over contain some silver. If intended for sale in that state, it is then sifted and packed in barrels; but if it is to be manufactured into pure lead, it is placed in a reverberatory furnace, with clean small coal, with which its surface is kept carefully covered, and exposed to a heat just sufficient to fuse it; the metal then flows into an iron pot, and is cast into pigs for sale.

In some works the reduction is performed in a blast furnace, but the lead is never so pure as that managed as described.

The volatile oxides of zinc, antimony, and arsenic, and a considerable quantity of the lead, are carried off by evaporation, during the process. A considerable portion of them are driven by the blast through the feeding aperture, and would be very injurious to the workmen, but for the arch over it, by which the fumes are carried by its flue into the chimney.

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*Analysis of Silver Coins. By* Thomas Thompson, *M.D. F.R.S.E.* —*Phil. Jour.* No. 59.

The silver coin was first cleaned with soap, or an alkaline ley. It was afterwards weighed, and its specific gravity determined, which varies somewhat according to the metal being rolled, hammered, or cast in a plate.

The coin was then put into a matrass, with a sufficient quantity of nitric acid, diluted with twice its quantity of water. When the acid ceased to act, the solution was poured off, and the black powder that usually remained, was repeatedly digested on a sand bath, with small quantities of nitric acid. It was then washed with distilled water, and dissolved in nitro-muriatic acid. The solution

was mixed with liquid sulphate of iron, and the black powder which fell, was washed and formed into a mass, sometimes by amalgamating it with mercury, and driving off the mercury by heat, sometimes by fusing it into a button by borax.

The metal thus obtained was the gold; it never exceeded $\frac{1}{200}$ part of the coin, and seldom amounted to $\frac{1}{1000}$ part. In some coins no gold was found. In the analysis of some of the coins, the black powder was fused into a button, and then treated with nitro-muriatic acid; if it left any residue of muriate of silver, it was weighed, its weight deducted, and the remainder considered as pure gold.

The nitric solution was precipitated by common salt, the precipitate carefully washed and dried, and the weight of the muriate of silver thus obtained accurately ascertained. The silver contained in this muriate was mostly estimated from the result of a standard experiment, tried on 100 grains, by which it was ascertained that muriate of silver, dried at a heat of 400, contained 0.7554 of silver, and when fused 0.7764.

A polished plate of iron was then put into the liquor, which was diluted with water till it covered the upper end of the plate. It was put by for two days or more, till all the copper was precipitated on the iron, which was then withdrawn, and the copper washed from it with distilled water, and then washed with water acidulated with muriatic acid, as was also any portion of the copper which fell off in removing the iron plate; the whole was collected on a filter, washed, dried, and weighed; and considered as the copper contained in the coin.

Almost the whole of the copper will be obtained by polished iron; by rough iron, the portion in its interstices cannot be separated.

Zinc did not answer so well for throwing down the copper; part of it adhered to the zinc, and part was precipitated in an alloy.

When diluted muriatic acid was poured on copper precipitated by zinc, a curious phenomenon occurred. The effervescence was strong and sudden, and the gas separated was *nitrous gas*, as became evident by the red fumes generated.

The following Table exhibits the products of the different coins analyzed.

| Names of the Coins. | Silver. | Copper. | Gold. | Loss. | Total Weight. |
|---|---|---|---|---|---|
| | grains. | grains | gr. | gr. | grains. |
| 1. Ancient. | | | | | |
| Grecian coin of Crotona — | 109.50 | 1.00 | .13 | 3.01 | 113.64 |
| Roman denarius of the Republic | 59.68 | 0.09 | 0.29 | — | 60.06 |
| ——— denarius of Domitian | 41.84 | 10.02 | .30 | .12 | 52.26 |
| 2. Modern. | | | | | |
| Rupee — — — | 146. 5 | 4. 5 | — | 1. 5 | 152. 5 |
| British, English half crown — | 201.23 | 17.00 | — | 2.27 | 220. 5 |
| ——— Scotch 40 shilling piece | 24.96 | 1.90 | — | 0.19 | 27.05 |
| French half crown — — | 190. 5 | 19. 2 | 0. 3 | 1. 5 | 211. 5 |
| Spanish pisterine — — | 71 | 13 | — | 1. 5 | 85. 5 |
| ——— pisterine — — | 90.95 | 5.53 | — | 2.59 | 99.07 |
| ——— dollar — — | 370.69 | 42.29 | 0.29 | 1.89 | 415.16 |
| Portuguese, a 12 vinteen piece | 103 | 12 | — | 2 | 117 |
| Dutch guilder — — | 150.37 | 10.72 | .06 | 2.78 | 163.93 |
| Sardinian — — — | 122 | 13 | — | — | 135 |
| Swiss — — — — | 57. 5 | 15. 5 | — | — | 73. 0 |
| German Hamburgh — — | 25.35 | 22.71 | — | 2.36 | 50.44 |
| ——— ditto — — — | 23.83 | 22.60 | — | 0.27 | 46. 7 |
| ——— Austrian crown — | 403.15 | 41.86 | .40 | .28 | 445.96 |
| Danish, a 60 shilling piece — | 390.60 | 53.68 | 0.09 | .15 | 444.55 |
| Russian, a 15 copec piece — | 40.04 | 11.39 | — | 1.54 | 52.97 |

The small quantity of gold found in these coins may be considered entirely as accidental.

The quantity found in the ancient coins, particularly in the Roman, greatly exceeds that found in modern coins.

The ancient Greek and Roman coins seem to have been formed of pure silver, the little alloy they held was doubtless accidental; but in the reign of Domitian, copper alloy was used, his coins containing 19.05 of copper.

The rupee is likewise almost pure silver; but as there are various sorts of this coin in India, they may differ in this respect.

All the European coins are alloyed with copper: the British is the purest, and the Hamburgh the least pure.

The following Table exhibits the proportion of alloy in these coins, arranged according to their purity. The first column gives the supposed proportion of alloy in 100 parts; the second gives the weight of silver, supposing the weight of the copper alloy to be always 1.

| | Alloy per Cent. | Weight of Silver, Copper being 1. |
|---|---|---|
| British | 7.5 | 12.5 |
| Dutch | 8 | 11.5 |
| French | 9 | 10.1 |
| Austrian | 9.5 | 9.5 |
| Sardinian | 9.5 | 9.5 |
| Spanish | 10.5 | 8.5 |
| | 15.5 | 5.5 |
| Portuguese | 11 | 8 |
| Danish | 12 | 7.3 |
| Swiss | 21 | 3.8 |
| Russian | 24 | 3.6 |
| Hamburgh | 50 | 1 |

# CHEMISTRY AND MINERALOGY.

*Observations on the Analysis of sparry Iron Ore. By Mr.* Hassenfratz.—*Journ. des Mines,* No. 103.

Mr. Berthier having made considerable researches into the nature of the white sparry iron ore, found that the ore of Saint Georges de Heurtriéres contained only $\frac{1}{100}$ of carbonate of lime; it was also found by Mr. Bouesnel that the ore of Allevard did not contain a much larger proportion of carbonate of lime. This singular result occasioning further researches, Mr. Bergman found in one specimen of a white colour with rhomboidal crystals 48 carbonate of lime, 25 black oxide of iron, 6.8 carbonate of iron, 3 sulphuret of iron, a loss of 17.2 being sustained, which was probably water. Another specimen of a lamellated texture and black colour, said to have come from the mines of Allevard, yielded 62 black oxide of iron, 5 carbonate of lime, 16.9 carbonate of iron, a loss of 16.1 being sustained.

The result obtained in the Ecole des Mines at Paris was 16.7 silica, 1 lime, 57.3 metallic iron, 1.56 metallic manganese, a loss of 23.44 being sustained, and which was attributed to oxygen, water, &c. Specimens of the ores analyzed by Mess. Berthier and Bouesnel were sent to Mess. Vauquelin, Drappier, and Thenard: the former has not communicated any account of his researches; the results acquired by Mr. Drappier are related in the following paper. Mr. Thenard's analysis was conformable to those of Mess. Berthier and Bouesnel.

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*Observation.*—In a note to the editors of the Journal des Mines published in No. 105, Mr. Thenard wishes it to be understood that he did not make a complete analysis of the ore sent to him, but that he only sought for the presence of carbonate of lime, agreeable to Mr. Hassenfratz's desire. In order to determine this point, he dissolved the ore in muriatic acid; during the solution much carbonic acid gas was emitted; he then precipitated the oxide of iron by means of ammonia, and afterwards poured into the liquor some oxalate of ammonia, which rendered it very slightly turbid; so that Mr. Thenard concludes this ore does not contain any silica, but a large quantity of carbonic acid and oxide of iron, with only a very small quantity of carbonate of lime, which is accidental.

Mr. Bergman has since, in a separate paper (see p. 339), acknowledged some very considerable errors in his analysis.

The results here stated are such as must occasion no little surprise, especially as they implicate in some measure a censure upon the analytical abilities of the celebrated Bergman, of Upsal, who, in an express essay on the subject, had affirmed that a Swedish specimen of this ore consisted of the following substances: oxide of iron 22, oxide of manganese 28, lime 26, carbonic acid 17, water 6; and that a specimen from Stiria contained 38 oxide of iron, 24 oxide of manganese, 19 lime, 10 carbonic acid, and 9 water.

Mineralogists, therefore, relying on this analysis, especially as it is strengthened in some measure by the similarity of structure exhibited by this mineral and calcareous spar, have constantly considered this ore as analogous to that spar, differing only in the quantity of metallic oxides which it contained. Hauy has even united them into one species; but the discovery of Berthier having given occasion to a more ample examination of this ore, as may be seen by the following papers, it appears that we must subdivide the sparry iron ore into several distinct species.

*Analysis of white or sparry Iron Ore.* *By* J. J. DRAPPIER.—*Ann. de Chim.* No. 168.

THIS ore is usually said by chemists to consist of iron and manganese, combined with lime, carbonic acid, and some water; and it has accordingly been arranged by Hauy as a variety of carbonate of lime, under the name of "*chaux carbonatée ferrifère, avec manganèse.*"

Three specimens were analyzed—1°. from Baigorry, of a grayish white in crystals (called by Hauy "*equiaxe*"), whose specific gravity was 3.83, and which yielded 40 per cent. of iron —2°. from Vaunaveys, of a brownish yellow rather deep, not crystallized, specific gravity 3.60.—3°. from d'Allevard; resembling No. 2, but crystallized. In all these specimens, the rhomboidal fracture, which has caused these minerals to be called sparry, was very distinct.

Dilute sulphuric acid dissolved by heat the whole of these minerals, except a little silica in the 3d, and did not deposit any thing on cooling: neither did the solutions in muriatic acid yield any precipitate with oxalate of ammonia. So that these minerals do not contain any lime!

In order to separate the manganese, the minerals were dissolved in nitric acid, and evaporated to dryness. This operation was repeated, to oxidize the iron more perfectly. The soluble part was then taken up by water; and there were left from 5 grammes of each specimen, the following quantities of red oxide of iron, viz. from No. 1, 3.05 grammes; No. 2, 2.45 gr.; and from No. 3, the same quantity. As the minerals themselves, when melted with potash, and elixiviated, gave a very feeble shade of green to water, it is probable that this oxide contains an inappreciable quantity of manganese.

The filtered liquor was colourless, and yielded, by the addition of carbonate of soda, a very light precipitate, in white flocks; but as some of this substance appeared to be retained in solution by the carbonic acid, the liquor was boiled, and being then filtered, and the precipitates calcined for a short time, weighed as follows: No. 1, 0.25 gramme; No. 2, 0.70 gr.; No. 3, 0.68 gr.

The properties of this precipitate surprised Mr. Drappier, not being those of the oxide of manganese, as he expected. Its appearance was gelatinous. After calcination it was equally white as before. It melted with glass of borax, by the blowpipe, and did not colour it; nitrate of potash added to the globule did not produce a violet colour: it did not become brown by exposure to the air; when dissolved in sulphuric or nitric acid, it was not

precipitated by the hydrosulphurets, nor by the alkaline prussiates: these last produced a very slight shade of blue; the oxalate of ammonia yielded by degrees a light precipitate, which redissolved in water, or by an excess of acid.

These properties indicated an earthy substance; and probably magnesia, especially as it formed a bitter salt with sulphuric acid, and was not precipitated from its solutions in acids (when they were sufficiently diluted with water), by the carbonates of soda, or of ammonia. Precipitated by the caustic alkalies, it was insoluble in an excess of those alkalies, but soluble in carbonate of ammonia. The retention of carbonic acid, after a long calcination, is the only property in which it seems to differ from magnesia; but Mr. Drappier thinks it is not so easy to separate by calcination the carbonic acid from magnesia, as is usually imagined.

Five grammes of each specimen were also calcined, and lost as follows—No. 1, 1.70 gramme; No. 2, 1.85 gr.; No. 3, 1.83 gr. This loss is probably owing in part to water, as well as to carbonic acid.

As the mineral yields nitrous gas, when dissolved in nitric acid, the oxide of iron is probably at the minimum of oxidizement; and therefore, admitting the exactness of Proust, in regard to the proportion of oxygen in that oxide, the results of the analysis may be stated thus:

| | No. 1. | No. 2. | No. 3. |
|---|---|---|---|
| Oxide of iron - | 52.75 | 42.38 | 42.38 |
| Magnesia - - | 5 00 | 14.00 | 13.60 |
| Water and carbonic acid | 42.25 | 43.62 | 43.22 |
| Silica - - | - | - | .80 |
| | 100.00 | 100.00 | 100.00 |
| The respective quantities of oxide would produce, metallic iron - | 41. | 33. | 33. |

Mr. Drappier thinks it probable that Prof. Bergman mistook magnesia for oxide of manganese.

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*Chemical Observations upon sparry Iron Ore. By Mr.* Collet Descostils.—*Journ. des Mines*, No. 105.

Many different analyses have been given of this ore; and the practice of iron-masters in respect to smelting it differs much from the opinion which the greater part of these analyses give of its contents.

Bayen was the first chemist who analyzed sparry iron ore. His experiments plainly shewed that it contained carbonic acid, and that

it was usually accompanied with fragments of quartz. The solutions of it in sulphuric acid sometimes yielded sulphate of lime, but at other times none could be obtained, so that the presence of lime seemed to be accidental. As that chemist found that this ore when roasted was rendered attractible by the magnet, that it dissolved with effervescence in nitric acid, that it reduced minium by being heated with it, and that it decomposed sulphuret of quicksilver, he supposed that the iron was in a metallic state. By dissolving the ore in nitric acid, evaporating the solution to dryness, washing the residuum, and precipitating the lixivium by a fixed alkali, he obtained a white earth which he thought was lime. When the ore was dissolved in muriatic acid small black flakes appeared, which he thought was zinc, and this latter supposition appeared to him the more probable, because a solution of sulphate of iron digested upon the ore, yielded, by evaporation and cooling, some crystals which appeared similar to those of sulphate of zinc.

Dize, struck with this result, dissolved some of the same ore as had been analyzed by Mr. Bayen in nitric acid, and by subsequent evaporation, elixiviation, and precipitation by a fixed alkali obtained $\frac{1}{10}$ of a white earthy substance, which on sublimation with charcoal yielded a few globules of zinc. Of the nitric solution, which had not any excess of acid, Dize observes, that it had a saline taste, and was not rendered turbid by prussiate of lime. He also observes that neither oxalic acid nor sulphuric acid shewed any signs of its containing lime. Mr. C. D. has repeated these experiments with the sparry ore from Vaunaveys, with the same results, except so far as regards the zinc, of which he could not find the least trace.

Almost at the same time that Bayen published his analysis of this ore, other experiments were published by Bergman. He shewed that the iron in this ore is oxidized to the same degree as in the green sulphate of that metal, and he considered lime as an essential ingredient, although he found the proportion of it to be very various. The existence of manganese in a large proportion, and its influence upon the iron produced from the ore, were important facts: it must be admitted, however, that the means he employed to separate the two metals, viz. by nitric acid and sugar, were very incomplete.

Sage did not admit the presence of lime as an essential ingredient, but he allowed of the same proportion of manganese as had been stated by Bergman. Sage also stated that he obtained a sulphate of manganese in white tetraedral prismatic crystals, which crystallized before the sulphate of iron obtained by the same application of the sulphuric acid. But these characters are not those of sulphate of manganese, but those of sulphate of zinc; so that the deductions of Bayen were really confirmed in lieu of being overturned.

Bucholz has lately published an analysis of a native carbonate of iron, which, from the description he gives of it, is evidently sparry iron ore. It contains, according to him, 59½ per centum of black oxide of iron, and 2½ of lime, which he suspects to be only accidental. This chemist could not discover any ponderable quantity of manganese, and relates so many trials, that it is evident that the specimen he examined did not contain any other earthy or metallic substance. He also observed that the carbonic acid was decomposed during the calcination of the ore, and was changed into a gas which burned with a blue flame.

Lastly, Drappier has recently published an essay (see the preceding paper), and announced that he found a large proportion of magnesia in this ore: a young chemist of the name of Bergman has also made some experiments, by which he is led to coincide with Drappier and others, that lime is only an accidental ingredient in this ore.

Mr. C. D. in order to discover the reasons of this great difference among chemists, made a comparative analysis of two varieties of this ore.

1. A specimen from Vauvaneys (the identical specimen that was analyzed by Drappier) of a brownish yellow colour. Its specific gravity was 3.6. It was semitransparent; its fracture was lamellar and shining; the lamellæ were perfectly flat; assayed with borax and oil it produced 34 per cent. of iron. It yielded by analysis 49 parts of red oxide of iron, 1.5 oxide of manganese, 12.5 magnesia, 0.3 lime, the loss by calcination was 37.5, so that 0.8 had been gained in the operations.

2. A specimen from Allevard, but different from that analyzed by Drappier. Its specific gravity was 3.84. It was grayish, opake, and its fracture was rather brilliant. Its crystallization was very confused, so that the lamellæ were frequently turned over one another. The sides of the fissures which traversed this specimen had frequently a very black colour, and they were nearly of a metallic lustre. The gray part was chosen, and on assaying it, 37.6 of iron was produced in one experiment, and 38.2 in another. By analysis it yielded 2 parts of fragments of quartz, 50 5 red oxide of iron, 9 to 10 oxide of manganese, 2 at the utmost of magnesia, 0.5 lime, the loss by calcination was 34.5; so that there was a deficiency of 1.5 in the whole 100 parts.

The process used in the analysis was the solution of the ore in nitric acid, evaporation of the solution to dryness, and redissolution of the saline contents; the manganese was precipitated by prussiate of potash, and the earths by potash; the lime was separated from the magnesia by sulphuric acid.

It plainly appears that the sparry ore of iron is very variable in its composition; and it is probable that the sulphate of magnesia was mistaken by Bayen and Dize for that of zinc, and by Sage for that of manganese. Mr. Descostils thinks it is also probable

that these chemists had chosen the most regularly crystallized specimens, and that these have the most magnesia in their composition.

It would certainly be very advantageous to be able to distinguish the composition of the ore by its external characters. In Dauphiné the miners distinguish two kinds of this ore: the first kind they call *maillat*, which is composed of large flat lamellæ; it is esteemed difficult of fusion, and yields a grey cast iron, which produces soft iron on being refined. The other is called *rives*; its crystallization is confused, and the grains are small; it is esteemed for its fusibility, it yields a white cast iron, which is easily converted into steel. The cast iron produced from these different kinds of ore are advantageously mixed for the preparation of steel. Mr. C. D. thinks that the specific gravity, the quantity lost by calcination, and the time they take to change their colour, may afford better indications of their composition.

In general, the sparry iron ore is esteemed the most fusible ore of that metal, and yet in most countries they add various substances to assist the fusion, as lime, argillaceous ores of iron, &c. Even with these additions it requires 2.3 or 3 parts of charcoal to produce 1 of cast iron, and the scoria always contain globules of metal. In some countries the ore is exposed to the air either before or after roasting. At Eisenerz, in Stiria, they do not roast the ore, but leave it exposed to the air for 50 or 60 years; and at Mont Blanc, some iron-masters keep the roasted ore constantly moist by a small rill of water passing over it. Notwithstanding these precautions, it is sometimes necessary to add what is called *mine douce* (fusible ore), or that which is entirely decomposed by the action of the atmosphere.

The separation of the sulphate of iron that is formed by the decomposition of the pyritous particles with which the ore is usually mixed by the rain, would naturally diminish the fusibility of the ore: it is therefore necessary to discover some other cause for the increased fusibility, which is the consequence of the above processes. It is stated above, that the distinctly lamellated kind is esteemed the most difficult of fusion, and that in this kind magnesia abounds; now this earth is not only difficult of fusion by itself, but diminishes the fusibility of the compounds into which it enters.

The two specimens analyzed by Mr. C. D. were pulverized, mixed with a little oil, and heated in a crucible lined with charcoal and clay. That from Allevard was perfectly melted, and covered with green scoria; but that from Vaunaveys, although exposed to a greater degree of heat, formed only a slightly coherent mass, interspersed with small globules of iron. Yet this last specimen, when the magnesia was extracted from it, being exposed in a similar manner, to a less degree of heat, yielded a well-formed button, covered with a few brownish scoriæ; the button was

slightly ductile. Hence it seems evident that these ores are more or less fusible as they contain less or more of magnesia, and that those that do not contain that earth, but contain manganese, are very fusible.

As to the theory of the preparation usually given to these ores before they are smelted; Mr. C. D. thinks that in ores which are not roasted, it principally depends upon the extraction of the carbonate of magnesia by the rain during the long exposition of the ore to the weather. As to the ores which are roasted, they always contain pyritous matters; the sulphate of iron which is formed by that process is decomposed by the pure magnesia, and the sulphate of magnesia is separated by the rain. But as these processes are necessarily of very long duration, and require of course great advances of money, the iron-masters find it necessary to abridge the time, by adding ore of easy fusion, or other additions.

It is to be remarked that, at least in assays of this ore, the manganese contained in it does not scorify, but forms an alloy with the iron. All the assays Mr. C. D. made of the specimen from Allevard yielded white buttons, which contained a large proportion of manganese. Assays of the ore of Vaunaveys, and some iron from Vierzon, gave only some slight traces of manganese on trial. The means he employed to discover manganese was to dissolve the button in aqua regia, to precipitate the solution by ammonia, and to ignite the precipitate with pure potash in a silver crucible. The potash which he used was so pure, that it remained perfectly colourless when ignited by itself in silver vessels.

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*Analysis of a Carbonate of Lime. By M.* Berthier.—*Jour. des Mines*, No. 109.

This carbonate was found in a vein at Pesey, crystallized along with quartz and lenticular brown spar. Its specific gravity was 2.97. Its form was the primitive rhomboid of common calcareous spar. It split with great facility, and might be divided in the direction of the great diagonals. Its transparency and limpidity were sometimes perfect, but generally it had a slight tinge of yellow, becoming opake, and being covered with a brown oxide by the decomposition it underwent in the moist places of the mine. By the blowpipe it became black and weakly attractible by the magnet. It would scarcely effervesce with acids unless reduced to powder, and then when aided by heat it suddenly effervesced strongly, and became of a reddish brown colour.

It was found to contain 43.5 of lime, 10 of magnesia, 8 of oxide of iron, 3 of white oxide of manganese, 26.5 of water and carbonic acid. In another trial 4 parts of white oxide of manga-

nese were obtained, so that no doubt could remain of its presence. Hence this mineral contains the four several carbonates of lime, magnesia, iron, and manganese; and it may be concluded from all that has said that these carbonates may occur united in various proportions, so that it is no wonder that we sometimes find sparry iron ore, containing magnesia but not manganese, and at others containing manganese without either lime or magnesia. Hence the analysis of these substances is more and more interesting.

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*Chemical Examination of a sparry Iron Ore sent by Prof.* Bergman *to* Guyton. *By* Collet Descostils.—*Ann. de Chim.* No. 173.

On account of the results lately obtained in the analysis of sparry iron ore being so very different from those stated by Prof. Bergman, Mr. Guyton, who had received from Bergman himself a small specimen of the very ore that he analyzed, desired Mr. Descostils to analyze some fragments of it, weighing 388 centigrammes, or 60 grains English, in order to discover whether the differences arose from a difference in the composition of the ore, or from some error in the analysis.

Its specific gravity was 3.963. It was brownish yellow, scarcely translucid. Its crystallization was rather confused; the plates were very small and a little twisted. It effervesed in dilute sulphuric acid; the analysis was conducted with the greatest precaution to examine the true nature of the products obtained. The solid products (which were all that could be properly ascertained, considering the small quantity operated upon) were 2.58 fragments of quartz, 48.45 red oxide of iron, 1.80 brown oxide of manganese, 0.52 lime, 1.98 magnesia; the remainder was either water, carbonic acid, or unavoidable loss.

Hence it is probable that Bergman did not examine with sufficient care the products that he obtained; it is also likely that he examined some other ores of this kind, in which the magnesia, which he mistook for lime, was more abundant.

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*On sparry Iron Ore. By Mr.* Bergman.—*Jour. des Mines,* No. 111.

Mr. Hassenfratz, as we have seen in a former paper (p. 331), has already published the analyses made by Mr. B. of two specimens of this mineral, sent to him by Mr. Hauy. The difference which exists between the results of these analyses and those since published by Mr. Drappier (p. 333), obliged Mr. B. to examine the products he had obtained, and which he had preserved.

The 48 parts of lime stated by him to have been extracted from the white sparry ore, were therefore treated with dilute sulphuric acid, in which they formed a voluminous magma, which appeared to resemble sulphate of lime. It was dried, slightly calcined, and elixiviated with a small quantity of water; the solution was bitter like sulphate of magnesia, but slightly metallic, which was found to arise from the mixture of manganese. The oxide of iron of the former analysis was found by being repeatedly treated with purified potash to contain manganese. In consequence of this examination of the products, Mr. B. corrects his analysis of white sparry iron ore as follows: pyrites 3, iron 20.5, manganese 4.5, carbonic acid united with the iron 6.8, carbonate of lime 41, carbonate of magnesia 7, water and loss 17.2.

The 5 parts of lime said to exist in the black sparry iron ore, were, on examination, found to consist entirely of magnesia and manganese; the iron also contained manganese; so that the analysis when corrected stands thus: oxide of iron and of manganese 64, carbonic acid united to these two metals 16.9, carbonate of magnesia 3, water and loss 16.1.

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*Observations.*—The present instance will teach us to beware of trusting the analyses even of the most eminent chemists. How many minerals are there whose composition is determined only by the cursory analysis of some single artist; and the principles of which were known but by crude conjectures! These, and the coincidence of the weights of the products obtained with the original quantity, satisfying the minds of most chemists, who are in general so eagerly engaged in endeavouring to discover some new metal or acid, that they cannot bestow the time necessary to the patient and laborious examination of the products, or to the verification of the analysis by other modes of procedure.

At the conclusion of his paper, Mr. Drappier, referring to the similarity of structure which is found in this ore, and in the native carbonate of lime, says, "We may from hence conclude, that the characters taken from the form of the molecule, and of the crystals, will not suffice to distinguish the several species of minerals from one another."—By these expressions, which are directed against the brilliant observations of Hauy, Mr. Drappier only shews how little he is acquainted with the system of that mineralogist. For Hauy constantly defines a mineral species by the aggregate of its properties; and as constantly acknowledges the insufficiency of the primitive crystalline forms to determine them, although he contends, that in conjunction with some simple trials they may afford considerable certainty, and have the advantage of being, for the most part, of easy acquisition. Several of the French chemists, however, have fallen into the same error of ascribing to Hauy, the idea of its being possible to recognise all mineral species by their crystalline forms. Even Berthollet, the

only philosophical chemist in that school, is not exempt from this fault.

As, therefore, Hauy disclaims the sole sufficiency of the crystalline forms, it is evident that the results of this analysis cannot be alleged against him, because in arranging this ore along with the carbonate of lime, he relied upon the accuracy of Bergman. But the case is entirely different with the chemists, who pretend to decide ultimately, and without appeal, on the constituent parts of minerals, since here we see that very different results have been obtained by different persons, some of whom hold the highest rank in the science.

It seems evident from the analysis of Descostils, that two distinct saline minerals have been confounded together under the common name of white or sparry iron ore; the one a carbonate of iron and magnesia, the other a carbonate of iron and manganese. The crystalline texture of the first is regular, that of the second confused. It remains to determine the truth of this conjecture, and in that case to shew the oryctognostic and geognostic characters, by which the difference of the two species can be determined with the utmost precision. But the observations of Berthier seem to shew that sparry iron ore may be still more diversified in its composition.

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*On the Composition of Carbonate of Lime. By* Descostils.—*Jour. de Phys. Mai* 1806.

Mr. Descostils dissolved aragonite of Auvergne in muriatic acid, and found that the solution did not afford any precipitate on the addition of ammonia, nor of sulphuretted hydrogen: hence it was evident that this stone did not contain any iron or manganese, agreeable to Mr. Proust's idea.

The solution of a specimen of very white and transparent calcareous spar assumed a yellowish colour by ammonia, and let fall black flocks on adding [sulphuretted] hydrogen; so that iron was evidently contained in this specimen. But some calcareous spar from Feroe, which was still more transparent than the other, being treated in the same manner, did not shew any signs of containing metallic oxides.

Hence Mr. Descostils thinks that we must seek for some other cause of the difference between the crystallization of the aragonite and calcareous spar.

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*On the Composition of the Carbonates of Lime. By Mr.* ***.—*Ann. de Chim.* No. 173.

Very pure calcareous spar was dissolved in dilute nitric acid, and a portion of the solution was poured into prussiate of potash;

a white precipitate was formed, which was redissolved by the addition of muriatic acid. The solution was colourless, but in a few days it acquired a slight blue colour just equal to that acquired by the prussiate of potash itself, to which a little muriatic acid had been added. No sensible precipitation took place: hence we may conclude that the spar did not contain manganese, and that the slight trace of iron was owing to the prussiate itself.

The nitrous solution was evaporated to dryness; fresh acid was added, and again abstracted. The residuum was still white, and completely soluble in water. The solution added to prussiate of potash gave, as before, not the least sign of iron or manganese.

Calcareous spar and aragonite were dissolved separately in nitric acid; the gas disengaged during the operation did not destroy the polish of the tubes adjusted to the matrasses. Neither prussiates nor sulphuretted hydrogen gave any signs of the solutions containing a metallic substance. Ammonia was not rendered turbid, nor lime-water, nor muriate of barytes. The addition of a sulphate did not exhibit any signs of barytes, or of strontian. Solution in dilute sulphuric acid and subsequent crystallization did not point out any difference between these two stones; so that the iron and manganese found by Mr. Proust in the former were probably owing to some impurity; and both the calcareous spar and aragonite appear to be mere carbonates of lime.

It would be proper for persons who mean to pursue this subject to examine the hard carbonate noticed by Bournon. Notwithstanding its characters are different from those stones examined above, the analysis of it by Chenevix exhibits no difference.

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*Observations.*—We have here another instance in which the resources of chemistry fail. The great difference between the several minerals which upon analysis exhibit only carbonate of lime, evidently shews the presence of some principles which the balance will not discover, at least in such small portions as are used by the chemists.

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*Observations on the Root of Ipecacuanha. By Mr.* Henry.—*Ann. de Chim.* No. 169.

Notwithstanding preceding experiments indicated the ligneous part of the root of ipecacuanha to be equally effective with the cortical, apothecaries were obliged to reject the ligneous part when they prepared the powder of that substance. Fresh experiments made in the hospitals at Paris evidently shewed that the ligneous part, when powdered, was equally emetic and purgative as the other; but to put an end to every doubt, Mr. H. made the following comparative experiments.

Ten grammes of the cortical part yielded to ether, 7 decigrammes of resin.

Another 10 gr. gave with alkohol, 6 decigr. of resin.

Another 10 gr. treated with warm water yielded 18 decigr. of a citron-coloured dry extract, entirely soluble in water, and slightly bitter.

Another 10 gr. by boiling in water yielded about 25 decigr. of extract.

The ligneous part treated in the same manner yielded to sulphuric ether 3 decigr. of resin, to alkohol 25 centigr. of resin, to warm water 14 decigr. of dry extract, and to boiling water 28 decigr. of extractive matter.

Four grains of the resin mixed with a little sugar, and 30 or 50 grammes of water, was emetic and purgative; but the extract was weaker, requiring 6 or 8 grains to produce the same effect.

The cortical part, when boiled in water, swelled like Bassora gum, (gum kutterah?) and when nitric acid at 30° was abstracted from it, it left malic acid; so that it is probably a gum mixed with resin and extract, which give it the emetic quality, as it has no such effect after it has been treated with water and alkohol.

When the cortical part is boiled in water, the water becomes turbid, and a cloud is formed in it; a whitish matter is separable by the filter. This matter somewhat resembles caoutchouc. It becomes coloured in time, but without being altered; and it dissolves with ease in ether, and in alkohol of 40°. It retains a large quantity of fecule.

The watery solutions both of the cortical and ligneous part, whether formed by decoction or infusion, exhibited the same effects with reagents. They immediately reddened tincture of litmus; they were not rendered turbid by solution of glue, nor by the sulphuric acid; they yielded a white precipitate with nitrate of silver; they were not precipitated by muriate of barytes, or tartrite of potash and antimony; they gave a slight precipitate with oxalate of ammonia: hence we may infer that the root of ipecacuanha contains a vegetable acid, and different salts with basis of lime.

The root of ipecacuanha distilled by the retort yielded water, oil, acetous acid holding oil, and elastic fluids. 30 grammes of the root, on being burnt to ashes and lixiviated, yielded only about 15 centigrammes of sulphate of lime mixed with a small quantity of some muriate, the basis of which could not be determined.

*Analysis of Rocksoap. By* BUCHOLZ.—*From Gehlen's Journ. der Chem. in Ann. de Chim.* No. 167.

A SPECIMEN of this mineral from Artern, in Upper Saxony, yielded, on analysis, 44. silica, 26.5 alumine, 8. oxide of iron 20.5 water, 0.5 lime, and a loss of 0.5 was sustained.

*Experiments upon Ivory, fossil Ivory, and the Enamel of the Teeth, to discover whether these Substances contain fluoric Acid. By* FOURCROY *and* VAUQUELIN.—*Ann. de Chim.* No. 169.

THE account given by Gay Lussac, of the discovery of fluoric acid in ivory, fossil ivory, and the enamel of the teeth, by Morichini (see p. 57), occasioned the following experiments:

The substances tried were previously calcined, in order to facilitate the action of the sulphuric acid. Fresh ivory lost by this calcination 45 per centum, Siberian fossil ivory 41½, that of Loyo 41, of the Canal du Lourque 18, of Peru 15, of Argenteuil 14, the enamel of the teeth lost only 11⅓, and became of a fine blue colour, owing to the quantity of phosphate of iron that it contains. The loss by calcination in the fossil ivories depends upon the quantity of gluten which they retain.

From 5 to 20 grammes (75—300 grains Engl.) of the calcined substances were then mixed with sulphuric acid, and the mixture heated. The enamel of the teeth, ivory, and the fossil ivories of Siberia and of Loyo, did not yield any trace of fluoric acid; the fossil ivories of the Canal du Lourque and of Argenteuil yielded very sensible traces of that acid, the inside of the tubes communicating with the vessel containing the heated mixture having lost their polish, and become covered with a white powder, which was silica. Fluate of lime being mixed with ivory, in the proportion of $\frac{1}{25}$, and even $\frac{1}{40}$, afforded still more evident marks of the fluoric acid; and hence it is evident that even in the fossil ivories of the Canal du Lourque and of Argenteuil there cannot be contained more than 3 or 4 per centum of that acid.

The chemists who announced the discovery of fluoric acid in ivory, recalled to our minds that Rouelle had formerly attempted in vain to obtain phosphorus from this substance. Mess. F. and V. however, extracted 15 grammes from 300 gr. of ivory, which is nearly the same proportion as is usually obtained from bones.

The piercing vapour which is exhaled on mixing the calcined ivory with sulphuric acid, does not, in Mess. F. and V.'s opinion, arise from fluoric acid, but from a portion of the sulphuric acid, which is exhaled along with the water in consequence of the great increase of temperature that takes place in the mixture.

The authors say they have attempted in several other ways to discover the existence of fluoric acid in these substances: particularly they heated ivory with sulphuric acid in a glass vessel, covered with a piece of moistened felt, but without success.

It is certainly singular, that although ivory does not contain fluoric acid, yet fossil ivory, from the most distant places, contains some portion of it. Hence it appears that it becomes impregnated with it; for to suppose that, according to the opinion of Klaproth, the phosphoric acid is partly converted into the fluoric, is very hypothetical.

If the fluoric acid really existed in ivory and the enamel of the teeth, we ought to find it in vegetable and animal substances, unless we supposed, gratuitously, that it was developed in the animal itself.

It therefore is most probable that ivory buried in the earth combines in process of time with fluoric acid; which acid may either enter into it from without, a supposition which requires the presence of fluoric acid in every part of the world, or else we must admit that some of the principles of the ivory are changed into fluoric acid. In our present ignorance of the nature of this acid, we cannot say that this change is impossible, nor indeed can we form any judgment respecting this transmutation.

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*Chemical Observations. By* A. F. Gehlem.—*Journ. de Phys. Juin* 1806.

These observations are contained in a letter from Dr. Gehlem to Mr. Delametherie.

Berzelius has found that if nitrous oxide is prepared from nitrate of ammonia containing muriatic acid, the gas contains oxygenized muriatic acid. In one experiment the oxygenized acid was so abundant that it not only communicated its smell and flavour to the water in the trough, but also rendered the nitrous oxide yellow. It could not be perfectly separated from the nitrous oxide by washing the latter with water. On respiration it produced the effects described by Proust. The ammonia which is combined with the muriatic acid is decomposed at the same time. Berzelius is certain that he has not mistaken nitrous acid for oxygenized muriatic.

Nitrate of ammonia, exempt from muriate, yielded, on decomposition by a well-managed fire, very pure oxide, so that it was almost entirely absorbed by alkohol, a very small residuum of azote being left. The oxide has a sweet, agreeable taste, which entirely fills the lungs; but neither Berzelius nor his friends have experienced the gentle intoxication said to be produced by the nitrous oxide.

Berzelius has verified the experiments of Morichini, and has found that the enamel of human teeth contains at most only three per cent. of fluoric acid. That acid is also found, but in very small quantity, in fresh bones, and even in urine, as might be expected. It were to be wished that these experiments were made upon a larger scale for the greater satisfaction. Some chemists have denied that human urine contains benzoic acid, yet a manufactory of sal ammoniac at Schoenebec, near Magdebourg, which employs urine, is able to furnish that acid by the hundred weight.

The same chemist says his experiments prove that the sebacic acid of Thenard bears the same relation to the benzoic acid that the zoonic acid of Berthollet bears to the acetic acid.

It has been said that Vauquelin and Laugier discovered chrome in the meteoric stones, but it was Lowitz that made that discovery, as may be seen in Gehlem's Journal, iv. 627. Biot is also said to suspect the existence of hydrogene in the diamond, but this has been announced several years ago, upon other considerations, by Winterl.

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*Observations.*—We have here another chemist of eminence and veracity, who not only affirms the enamel of human teeth to contain fluoric acid, but has even ascertained its maximum of quantity.

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## *On a new Principle in Asparagus. By Mess.* Vauquelin *and* Robiquet.—*Ann. de Chim.* No. 169.

Mr. Robiquet having left in Mr. Vauquelin's elaboratory some inspissated juice of asparagus, the remains of his analysis of that vegetable which was published in a former volume of the Annals, Mr. V. observed in this mass a great number of crystals, two kinds of which seemed to be new. As they were different in their appearance, they were easily separated.

The first kind became perfectly white and transparent when it had been crystallized several times; it had a sharp taste, rather nauseous, and excited the secretion of the saliva. It was hard, brittle, and of a regular form, which, according to Hauy, to whom some crystals were sent, was a straight rhomboidal prism; the greater angle of the base was about 130°; and planes were substituted for the edges of the base, and the two angles at the extremity of its grand diagonal.

Mr. R. observed this substance in his analysis of asparagus, but considered it as an ammoniacal salt, probably because, having only a very small quantity of it imperfectly purified, he was deceived by the ammoniacal salt with which the juice of this plant abounds.

It is soluble in water: the solution has no signs of acidity nor of an alkaline nature. Infusion of nut-galls, acetate of lead, oxalate of ammonia, muriate of barytes, and hydrosulphuret of potash, do not change this solution in the least. It is not soluble in alkohol. Triturated with potash, it yielded no trace of ammonia, but seemed to become more soluble in water. When exposed to heat in a platina crucible, it swelled considerably, and emitted at first vapours equally piercing as those of wood, and towards the end, others resembling those of animal matters; much charcoal remained, perfectly insipid, and which left upon incineration, an almost imperceptible quantity of earth that was certainly accidental. Nitric acid decomposes this substance; the solution becomes yellow, and bitter, as with animal substances. When the action of the nitric acid is over, the addition of lime causes an abundant emission of ammonia.

This substance is not acid, as it does not redden tincture of litmus; nor is it a neutral salt, since it contains neither alkali nor earth.

The other kind of crystals were equally white, but not so transparent; they were without any consistence, crystallized in fine needles, and had a sweetish taste, resembling manna, to which substance they had some similitude.

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*Experiments made by the Galvanic Society. By Mr.* Riffault.—*Ann. de Chim.* No. 169.

Mr. Maréchaux de Wesel having informed the Society that neither water nor any watery solution was necessary for producing galvanic effects with a pile; and that he had constructed piles of zinc and *brass* with discs of *unmoistened* pasteboard, the Society thought proper to repeat the experiments. They therefore formed a vertical column of 49 pairs of discs, made of zinc and brass, with other discs of unmoistened pasteboard interposed, upon a larger disc of brass having 3 holes near the circumference. The pile was suspended by means of silk strings, so as to form what Mr. M. calls a pendulous column. This pile, when applied to the electro-micrometer of Veau-Delaunay, exhibited a tension of 360°.

Four discs of blotting-paper being substituted for each pasteboard disc, no effect was produced. Pasteboard dried in an oven being used, the mean tension was 372°; the same discs, with 25 pairs of metallic discs, gave only 160°. Metallic discs only produced no effect. Hence, although some galvanic effects were produced by Mr. M.'s piles, yet they were very weak, and required the assistance of a very sensible instrument to discover them.

Dr. Joseph Baronio, of Milan, having published in the Moniteur a description of a galvanic pile formed entirely of vegetable

matters, the Society endeavoured also to repeat his experiment. The pile was formed of 60 pairs of discs, 2 inches in diameter, of beet-root and horseradish-root, with shallow discs of walnut wood boiled in vinegar between them; into these last was poured a solution of acidulous tartarite of potash in vinegar: the lower extremity of the pile stood upon a leaf of scurvy-grass (cochlearia); and upon the upper part was placed a double slip of blotting-paper soaked in vinegar. But they did not find that this pile had any effect upon prepared frogs, or even upon the electro-micrometer.

A pendulous pile of 60 pairs of new discs of copper, and of zinc, with unmoistened pasteboard placed between them, indicated 180°, and yet it had no effect upon prepared frogs. Whence it appears that the electro-micrometer is far more sensible to the smaller degrees of galvanism than frogs.

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*Chemical Examination of the fossil Bones found in the Department of the Maine and the Loire. By Mr.* Chevreuil.—*Ann. de Chim.* No. 169.

The bones analyzed were found at Chavaignes. When mixed with sulphuric acid, they effervesced, and on applying heat, the mixture emitted vapours of fluoric acid, which corroded glass. Some fossil teeth found in the same soil also yielded vapours of fluoric acid. They both contained phosphoric acid.

By a careful analysis, the particulars of which are detailed by Mr. C. 100 parts of the bones yielded $1\frac{1}{2}$ of sulphate of lime mixed with animal matter, $10\frac{1}{2}$ water, 67 phosphate of lime, and phosphate of iron-and-manganese, 1 alumine, 4 carbonate of lime, and as much fluate of lime as yielded 15 of carbonate of lime.

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*The Analysis of Bird-lime. By* Bouillon Lagrange.—*Ann. de Chim.* No. 166.

The bird-lime analyzed by the author, was prepared by himself, from the inner bark of the holly, by pounding it, boiling it in water for four or five hours, pouring off the water, and leaving it in a cellar until it became viscous.

Bird-lime thus prepared has a greenish colour, a bitter taste, it is sticky, and draws out into threads. Its odour resembles that of linseed oil. By exposure to air and light, it grows brown and dries. It may then be reduced to powder, and its glutinous characters are not restored by the addition of water. It reddens tincture of turnsol. By heat it melts, but does not become very

liquid; it swells up, and acquires a brownish colour, but on cooling it resumes its former properties. On live coals it burns with flame, and gives out much smoke. Heated in a crucible it inflames as soon as it is red, and the combustion continues although the crucible is taken from the fire. A white and very alkaline ash remains, which contains also the sulphate and muriate of potash, the carbonates of lime, and of alumine, and a little iron.

Water has little action on bird-lime; it becomes bitter, and reddens tincture of turnsol; by evaporation and treatment with alkohol, mucilaginous and extractive matter is separated.

Concentrated solution of pure potash dissolves bird-lime rapidly, and forms with it a kind of soap, which becomes hard in the air, and is very soluble in water and alkohol: these solutions are decomposed by acids.

Even weak acids act upon bird-lime; and when concentrated, their effects are considerable.

Sulphuric acid blackens it. On adding lime, a magma is formed, from which acetous acid and ammonia are disengaged.

Nitric acid has, when cold, little action upon bird-lime; but on applying heat, it becomes yellow, and a hard brittle mass is left. A fresh portion of nitric acid dissolves this resin, which is partly converted into malic and oxalic acids. By continuing the evaporation, a yellow, very friable matter is left, which softens upon handling, is very elastic, and melts with a slight heat. This kind of wax is also soluble in potash, forming with it a brown soap; it is partly soluble in alkohol, which becomes yellow, and on evaporation leaves a yellow matter, which has no longer a fatty appearance.

Muriatic acid has no action on bird-lime in the cold, but by heat the bird-lime grows black.

Oxygenized muriatic acid passed through bird-lime, kept melted in water, causes it to become white; to be no longer viscous, but to be divided into hard lumps, containing in their centres unaltered bird-lime. This oxygenized bird-lime may be reduced to powder, it is insoluble even in hot water, it does not melt at a high temperature, and it neither becomes yellow, nor forms a resin with nitric acid.

Acetous acid partly dissolves bird-lime; the acid acquires a yellow colour, and leaves on evaporation a resinous substance.

Litharge heated with bird-lime, became gray, and formed a kind of plaster.

Boiling alkohol, of 40 degrees, dissolves bird-lime, forming a transparent yellow solution which becomes turbid on cooling: a substance may be separated, by filtration, that has the appearance and characters of wax. The filtered solution is bitter, nauseous, precipitable by water, and leaves a resinous substance on evaporation.

Sulphuric ether is the best solvent for bird-lime; it acts very quickly, and forms a greenish solution, which reddens turnsol. If a little water is added to this solution, the ether separates; but if a quantity of water sufficient to dissolve the ether is added, a stratum of oil rises to the surface, which strongly resembles linseed oil, and forms a plaster with litharge. The ethereal solution leaves, on evaporation, a yellow, greasy, soft substance, like wax.

Hence bird-lime differs from gluten, by containing uncombined acetous acid; by partaking very slightly of an animal nature; by containing mucilage and extract; by the great proportion of resin which may be obtained by nitric acid, and by its being soluble in ether.

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*Observations.*—Thus another proximate principle is added to the constituent parts of vegetables, already sufficiently numerous to afford matter for experiments for ages of industry.

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*Analysis of Schillerspath. By* J. J. Drappier. *Jour. des Mines,* No. 102.

The schillerspath of the Germans is a mineral substance, having a play of colours, and composed of laminæ, which have in some positions a lively and almost metallic lustre, in others the lustre totally disappears. Its colour varies from different shades of green to brass-yellow, and sometimes it is even silver-white. It is easy to reduce to a powder, which is unctuous to the feel. The laminæ seem to be of a regular hexaedral form.

By the ingenious analysis of M. Drappier, it contains 41 of silica, 29 of magnesia, 3 of alumine, 1 of lime, 14 of oxide of iron, 10 of water, a loss of 2 parts in the 100 being sustained.

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*Observations.*—This analysis differs from those of Heyer and Gmelin, in that they state the alumine to be in a greater proportion than the magnesia.

Schillerspath is the Labrador hornblende of Werner; although Prof. Jameson, in his late work in mineralogy, has neither given schillerspath as a synonyme of that sub-species of the clay genus, nor even mentioned it. Hauy, however, who has bestowed much labour in separating minerals into distinct species, is rather of opinion that this union of schillerspath with hornblende (called by him amphibole) is incorrect, because, as is above hinted, the laminæ form an hexaedral prism; a form which is incompatible with the primitive form of the amphibole.

*On the Use of the different Species of Lycopodium in Dying.* By J. F. Westring.—*Bullet. des Scien. Therm.* 12. No. 89.

Mr. Westring is well known for the experiments he has made on the uses of the lichens in dying. In attempting to fix the colour produced by one of the species of that numerous genus, he made use of lycopodium complanatum: although he missed his original aim, he made the discovery of a new method of dying wool of a good blue colour, that did not leave any mark when rubbed upon linen, nor tinge the water in which it was rinsed, and which even resisted boiling with soap and water. The only inconveniency is, that the wool thus dyed becomes red with acids, but the colour is easily restored by a weak alkali.

The moss dried and cut is placed in layers, with half its weight of cloth to be dyed; water is then poured on it so as to keep it covered, and the whole is boiled for two or three hours, fresh water being added as the other boils away; the cloth is then taken out, wrung, and hung up to dry without rinsing. The cloth thus prepared is to be rinsed with cold water, put into a copper well tinned, and boiled along with a small quantity of brown brazil wood in river water, over a slow fire, for half an hour or an hour, according as the blue is wanted to be lighter or darker. The cloth is then to be rinsed in cold water. Instead of boiling, it is enough to macerate the liquor for a couple of hours in a heat of 60° or 78° Cels. A too large proportion of brazil wood produces a violet tinge in the colour: this wood may also be mixed at once with a strong decoction of the moss, but all saline or astringent preparations must be avoided.

The lycopodium clavatum (or club moss) may be employed for the same purpose, and it gives a much deeper blue. At present this plant, which is still more common (in Sweden) than the L. complanatum, is only used to make mats; the pollen indeed is used in medicine.

Lycopodium annotinum, instead of blue, produces different shades of gray. This common plant also affords easy methods of fixing several colouring matters upon cloths, which are at present very difficult.

L. selaginoides, and L. selago, instead of blue, produce a fine gray, which verges upon blue and violet.

L. alpinum, which forms the turf on the mountains of Lapland, produces a blue colour, that offers a greater resistance to acids.

Mr. Westring thinks great advantages may be gained by using these mosses, not alone as dye stuffs, but as a substitute for nut-galls, &c. He also thinks that substances may be procured so as

to render unnecessary the importation of brazil wood. The dried bark of the ash gives, when used with lycopodium complanatum, a changeable colour, between brown and blue; the green bark only gives a fine, but useless yellow.

Silk also may be dyed by means of the lycopodium complanatum and brazil wood; it takes a fine blue colour verging upon red; if the quantity of the wood is increased, the silk becomes of a puce colour.

Lichen parilis is the only lichen that yields a blue colour: half an ounce infused in river water for three days at the heat of 40° or 50° Cels. will colour a quart of water. Three or four quarts may be coloured by repeating the infusion in fresh water. But this colour cannot be fixed by any known method, it even disappears by the application of boiling water.

The bark of the withered branches of the plum-tree, taken off after the first frosts, yields a good carmelite colour. That of the populus dilatata (Lombardy poplar) communicates a good yellow colour both to wool and silk. This certainly is owing to the addition of lycopodium; for Mr. Dambourney, although he added the solution of tin in aqua regia, obtained only a false colour. Mr. W. also found that the addition of tin in solution improved the colour.

Wool passed through a bath of lycopodium, yields with lichen Westringii a fine and good orange colour, much superior to that produced by annotto. The same colour may be obtained by the lichen nereus, and a fine clear good yellow by the lichen chlorinus Achart. The lichen vulpinus produces by this means a fine, good citron colour. All these colours are changed by being treated with brazil wood; that dyed with L. Westringii becomes of a very deep blue black, that dyed with L. chlorinus of a fine green black, and that dyed with L. vulpinus of a blueish green.

Swietenia mahagoni will yield an aurora colour fit for cotton. Lichen parellus does not contain any colouring matter, the red colour usually said to be produced by it being owing to the use of other species.

The bark of the pine is an excellent tonic, and may even be substituted for quinquina: this bark is nutritious, and is made into bread in the northern parts of Sweden.

In Iceland they also have made bread of sphagnum palustre (common bog-moss): this bread is white, and is said to taste like the usual kind. A surgeon at Uleaborg, who has followed up these experiments, has found that this moss contains a great deal of saccharine matter.

*Description of the Peridot Idocrase, and four other new Species of Stones, viz. Succinite, Mussite, Alalite, and Topazolite, found in Piedmont. By* B. Bonvoisin.—*Jour. de Phys. Mai* 1806.

Mr. Bonvoisin intends to publish his travels in the Piedmontese Alps; but in the mean time, communicates some account of the new minerals he has discovered in them, and of which he has deposited specimens in the principal cabinets of Paris.

*Succinite* is found in irregular globular masses, seldom larger than a bean, which are either disseminated in a soft lamellar stone of the nature of serpentine, or in the true serpentine. Sometimes they form beds in this stone. Their colour is yellowish, approaching to that of honey. Their external surface resembles that of a resinous substance, which has lost its brilliancy by rubbing or handling. Their fracture is granular, translucid, and brilliant; the fragments are irregular, sharp-edged, and almost entirely transparent. They are very brittle, and may be easily reduced to powder. They do not strike fire with steel, nor scratch glass, but are scratched by it; they scratch calcareous spar, and yield a blackish glass by the blowpipe. They are found in the Vallée de Viu. Mr. Hauy has received from Germany a stone called colophonite, which appears to have some resemblance to them.

*Mussite* is crystallized in prisms, which are rhomboidal with obtuse rounded angles; they do not end in pyramids, being truncated by a rhomboidal plane. These prisms are brilliant, and streaked longitudinally. They are usually 2 or 3 millimetres ($\frac{1}{10}$ in.) broad, and 2 or 3 centimetres (1 inch) long; sometimes, but rarely, they are twice this size. Their colour is greenish white, and sometimes white, passing into apple green, but also a little pearly. They are usually opake, sometimes translucid, and at other times entirely transparent.

These crystals are imbedded perpendicularly in a grayish stone, which seems to be of a similar nature, and has the appearance of sand-stone. They are aggregated by their sides, and form by their summits (which are of different heights) a species of dendrites upon the surface of their matrix. Sometimes they diverge as from a centre, and at other times are aggregated in bundles. The prisms are also frequently curved. As these crystals are easily broke in a transverse direction, with perfectly smooth surfaces, this may be the cause of their being found truncated.

Their aspect is crystalline; they do not strike fire with steel; they neither scratch glass, nor are scratched by it. By the blowpipe they yield a glass of the same grayish colour. They are frequently found connected with metallic minerals, and particularly with specular iron ore.

They are found in the Plaine de la Mussa, imbedded, as we have said, in a grayish stone, which forms a kind of vein in a bed of very dark coloured serpentine. This gray stone has a fine granular fracture, it is rough to the touch, middling hard, and does not strike fire with steel; it is stratified, and the mussite is found in the fissure. Mr. B. thinks this gray stone is prehnite écailleuse.

*Peridot idocrase* is of a leek green colour, rather deep, sometimes nearly opake, and at others perfectly transparent. It forms a bed between serpentine. Crystalline druses of this substance are found in the horizontal fissures of this bed, and these druses are sometimes intermixed with noble garnets. The crystals are commonly rectangular prisms, surrounded by a quadrangular trapezoidal pyramid, truncated at the apex. The prisms are sometimes truncated by a very brilliant plane, perpendicular to their axis. These truncated prisms are sometimes found aggregated parallelly, so that the truncating planes of them form a brilliant and even surface. The regular and insulated prisms are most commonly very transparent, and may be cut into jewellery. The colour of these prisms sometimes approaches to that of the hyacinth, or of reddish white wine. This stone strikes fire with steel, and scratches glass. It melts easily, by the blowpipe, and froths in fusion.

It is found in the Plaine de la Mussa.

*Alalite* has commonly the form of flattened quadrangular prisms, surmounted by a pyramid of four planes, truncated at the apex. The prisms have sometimes all their lateral faces equal; sometimes the edges of the pyramid are truncated, and they have additional faces upon each angle; sometimes the bases of the prism are of an indeterminate figure. They are usually colourless, and almost perfectly transparent; sometimes they have a slight tinge of green; sometimes they have a whitish opacity; at others they are only slightly opake and white, where they are connected with their matrix. They are from 3 to 10 millimetres ($\frac{1}{10}$ to $\frac{4}{10}$ inch) thick, and generally about twice as long. They are always streaked longitudinally, and fibrous; even those that are transparent appear to be formed of parallel longitudinal fibres, which appear to be disposed in a kind of planes, that reflect the light. Upon this account the lateral faces of the prisms, although brilliant, permit the fibres to be seen in the interior of the crystal, which gives them a peculiar opalescent and pearly appearance, somewhat silvery, like that of adularia. The crystals are not hard, and may be scratched by glass: they melt, by the blowpipe, with some difficulty, into a glass of the same colour.

They are found in the Montagne de la Ciarmetta, most commonly formed into druses along with noble garnet. There is in the same place a vein of a white opake substance, which appears to be alalite in mass.

*Topazolite* is found in small dodecaedral crystals, with rhombic faces, which are imbedded in the same stone as the mussite, and frequently intermixed with that substance. They are always imbedded so deep, that only six of the faces can be distinguished, which are very smooth and brilliant; the largest are about the size of a chick-pea; the middling size are as large as the head of a small pin; while others are so very small, that, being closely aggregated together, they have only the appearance of a granular and rough varnish, spread over the matrix. Their colour is topaz yellow, passing to honey yellow, or wine yellow; sometimes they are white, passing into straw yellow. Some are greenish yellow, and lastly, a few insulated crystals have been found of a fine emerald green. Their fracture is uneven and angular, like quartz; the fragments are very sharp edged; they yield a whitish powder; they strike fire with steel; the faces are difficultly scratched by quartz or the file, but the latter has more power on the edges, because they are brittle, and easily broken. They scratch glass. Their specific gravity is 4.

They are generally found aggregated into small druses, of which the largest is not more than a decimetre (4 inches) in diameter.

Some crystallized topazolite ignited for two hours and a half, was not altered in form, weight, brilliancy, or transparency; but its colour was changed from jonquil or sulphur yellow, to dark honey yellow, inclining a little to green. By trituration it was reduced to a pale sulphur yellow powder, which by the help of pure potash was melted into a glass of a green colour. On pursuing the examination further, topazolite was found to be composed of 37 silica, 29 lime, 2 alumine, 4 glucina, 25 iron, and 2 of manganese, a loss of 1 part in the 100 being sustained in the analysis.

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*Notes on the above, by Mr. Delametherie.*

Succinite has a great resemblance to some hyacinthines (idocrase or vesuvian) in Mr. D.'s possession: but hyacinthine melts with ease into a glass of the original colour, while succinite is melted with more difficulty, and yields a blackish glass.

Among the specimens of the peridot idocrase left by Mr. Bonvoisin, which are very beautiful, no peridots (chrysolite or olivine) have been observed, but only hyacinthines.

Mr. Delametherie describes many of the crystallizations of the peridot idocrase and alalite.

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*Observations.*—The mussite here described seems, from its external characters, to be analogous to wavellite, if not the same.

The topazolite, notwithstanding its colour, must be arranged along with emerald and euclase, on account of its composition, as it differs from them only in the proportion of the component parts.

*On the Fastening of Iron in Stones. By* GILLET LAUMONT.—*Jour. de Phys. Juin* 1806.

THE fastening of iron with lead is commodious, easy, and very lasting, so that it is in general the best fastening. It has been said that the lead is not immediately in contact with the iron or stone, because of the diminution of volume which takes place when the lead is cooled. But this assertion is not true; for the coolness of the iron and stone causes an immediate setting of the surface of lead next to them, and the setting continues to advance from thence to the centre, where a manifest depression is made, unless the lead is used in a large quantity.

The fastening with sulphur is very commodious and very cheap. It might be usefully employed to fasten stony substances to one another; but sulphuric acid is soon formed, which acts upon the iron; and this by the augmentation of its volume, when *oxidized*, causes the remaining sulphur to scale off by degrees. This *oxidizement* of the iron takes place more particularly in those parts that are immediately above the sulphur, which are frequently entirely corroded for a decimetre (4 inches) or more in height. The sulphate of iron produced by this re-action of the sulphur and iron on each other, by the intermedium of water, also stains the marble or stone, a circumstance which is frequently very disagreeable.

The fastening with plaster of Paris has the advantage of setting quickly, and of being very strong, on account of the augmentation of volume that takes place when this substance sets; but it will not bear exposure to the weather.

The fastening with common mortar made of lime, sand, and pounded tiles, may be very good, but it does not acquire sufficiently quick the necessary consistence.

Iron may be very well fastened in stones by means of mixtures of filings, or scales of iron, with vinegar, soot, or urine. Mr. Gillet Laumont fastened, twenty-five years since, several rings in a stud stable, by means of linen rags moistened with a mixture of vinegar and soot, some nails and wedges of old iron being used to fill up the holes. This method is peculiarly adapted for the fixing of cramps in the upper part of an arch, where, by reason of the position, neither sulphur nor lead can be employed. It may however be dangerous when the holes are near the edge of the stone, or when too large a quantity of iron is employed; for then the augmentation of volume during the oxidizement of the metal will split the stone. With a view to diminish the effect of this augmentation of volume, the author introduced cork into the holes with success.

But to avoid the several inconveniences of the above method,

Mr. G. L. proposes the use of resinous cements, which are already employed by many artists to fix the metals or stones they intend to work upon. He has fastened a number of things with melted resin mixed with ashes or powdered bricks. This kind of cement is cheap, it does not act upon the iron, it unites perfectly with metals and stones, and it is not soluble in water. In order to give it a greater solidity, he introduced into the holes pieces of hot tiles, before he poured in the melted mixture, which rendered the whole stronger, and occasioned a more perfect adherence of the iron with the stone.

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*Observations.*—All the methods here mentioned are well known in this country, but that of causing iron to rust in the holes is by no means so often employed as it deserves. We have known even cast iron pots of very large dimensions, which had been cracked by accidents, to be rendered again serviceable, by filling the crack with iron filings, and moistening them with vinegar.

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## *On the Fall of two meteoric Stones. By Dr.* Pages *and Mr.* Dhombres Firmas.—*Jour. de Phys. Juin* 1806.

On the 15th of March 1806, at half past five in the evening, there were heard at Alais, and the neighbouring places, two loud claps, the one a few seconds after the other, which were taken at first for the report of cannon; they were followed by a rolling noise, which lasted ten or twelve minutes. A few drops of rain had fallen in the morning. The barometer, which stood at sunrise on the 14th at 0.751 metres, fell gradually, so that it stood at 0.745 on the morning of the 15th, but at noon it rose 0.0002. The sky then cleared up, but in the morning some clouds hid the sun every now and then. The centrograde thermometer marked 12.5 as its maximum. After the two claps the sky became more cloudy and dark.

At Saint-Etienne de Lolm, 12 chiliometres (7 miles) from Alais, two persons heard the claps, which they at first took for the report of cannon, fired towards Saint Hippolyte le Fort. But the rolling noise that succeeded, and seemed to describe a curve from west to south, and from thence to the east, undeceived them, and made them attend to the clouds. A sort of whistling noise succeeded to the rolling, and they immediately perceived a blackish body to come out of the clouds in the north, obliquely towards them, which passing over their heads, fell in a field at some distance with great noise. They and several others immediately searched for the stone, which had gone 0.12 metre (5 inches) under ground. The rock that formed the substratum, had split it into a number of pieces, some of which were found still warm, at the

distance of more than 8 paces. What remained in the hole, which was about 0.3 metre (1 foot) in diameter, were blackish fragments which were softened by the rain that fell the next day. Most of the pieces weighed from 50 to 70 grammes (about 2 oz. av.). One, however, weighs 556 gr. ($1\frac{1}{4}$ lb. av.). The stone was estimated to have weighed, when entire, about 4000 grammes (8 lb. av.). Its form, as far as could be judged from the fragments, was irregular and angular. It was black internally, as well as externally, and appeared to have been exposed to the action of fire.

At Valence, 18 chiliometres (10 miles) from Alais, four persons that heard the claps, and the rolling noise that succeeded it, were led, by another noise, that resembled that of an iron pulley when the rope runs swiftly over it, to regard the sky with attention. They perceived a black body come towards them from the north, which fell about fifteen paces from one of them, and buried itself about one half under ground. It was hot, and split into three pieces. Its form was somewhat cubical, about the size of a child's head, and it weighed about four pounds. The fragments of it adhered to a magnet, and it affected the magnetic needle. It did not strike fire with steel. When put into water, it diffused itself in the water like clay, small bubbles of gas being disengaged. Hence it appears that these stones differ from those which have fallen elsewhere.

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*Observations.*—Mr. Delametherie informs us in a note, that these stones have been analyzed at Paris, and that he means to publish their analysis in a short time.

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*A chemical Examination of native Cinnabar. By Mr.* Klaproth. —*Neue Allgem. Jour. de Chemie, Band V. or Jour. des Mines*, No. 112.

The cinnabar brought from Japan is in insulated grains more or less crystalline. Its colour, where it is not injured, is deep cochineal red, approaching to steel gray; but where rubbed it is scarlet, approaching to brick red. The grains are, in fact, fragments of flattened hexaedral prisms; externally they are sleek, and of a metallic splendour; internally they are very brilliant, and of a semi-metallic aspect. The cross fracture is conchoid, the longitudinal fracture is concealed foliated. The fragments are indeterminately angular, opake. It is soft; the streak is scarlet red. Its specific gravity is 7.710.

The fragments sometimes contain specks of pyrites, and sometimes they adhere to a quartoze matrix, so that 104 grains of the one, examined by Mr. K. contained only 100 grains of the pure

cinnabar; this latter was found to yield 84.50 quicksilver, and 14.75 sulphur.

The cinnabar of Terhitz, near Neumarktel in Carniola, is the most beautiful of the European cinnabars. Its colour is a lively cochineal red. It is found in considerable masses, in a blackish gray compact limestone, which is traversed by veins of milk-white calcareous spar. The external surface is of a semi-metallic brilliancy: the internal surface is slightly brilliant and greasy. The fracture is concealed foliated, and in some directions uneven. The fragments are indeterminately angular, with blunt edges. It is composed of thin separate pieces, striated on the surface. It is translucid, the streak is very lively scarlet red. It is very soft, and remarkably heavy, its specific gravity being 8.160. It contained 85 of quicksilver, and 14.25 sulphur.

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*On hepatic Ore of Quicksilver. By Mr.* KLAPROTH.—*Neue Allgem. Jour. der Chemie, Band V. and Jour. des Mines,* No. 112.

THE hepatic quicksilver ore of Idria, examined by Mr. K. was between dark cochineal red and lead gray. It is almost always found in compact masses; its external surface is brilliant, its internal surface has a feeble metallic appearance; it is opake; the streak is dark red brown, and has but little brilliancy. It is easily frangible, sectile, and heavy. The specific gravity is 7.100. It does not take a good polish, but assumes a light liver-brown colour, from whence its name is derived; 1000 grains of this ore distilled with iron filings, yielded 818 gr. of quicksilver, the residuum was sulphuret of iron mixed with a black powder, which fouled the hands like soot.

One hundred grains boiled in 500 gr. of muriatic acid, yielded sulphuretted hydrogen gas: 100 gr. of nitric acid being gradually added, the ore was dissolved, and only 10 gr. of a black powder left. By exposure to a gentle heat, the sulphur in this residuum was burned, and 3 gr. of charcoal remained, which on ignition left 1 gr. of reddish ashes. The nitro-muriatic solution yielded by muriate of barytes, a precipitate weighing 46.5 grains.

One thousand gr. of hepatic ore distilled by itself, yielded 24 cubic inches of sulphuretted hydrogen gas, besides what was imbibed by the water in the apparatus. Some quicksilver came over, and there was sublimed a mixture of ethiops mineral, a greasy moisture, quicksilver and cinnabar, from which 317 gr. of quicksilver were separated. The throat of the retort contained 256 gr. of cinnabar. A coaly residuum, weighing 39 gr. was left, which by combustion yielded 16 gr. of ashes. These ashes digested in muriatic acid, left undissolved 6.5 gr. of silica. The

muriatic solution, which was yellow passing into pale green, being supersaturated with ammonia, yielded a brown, viscous precipitate, and the supernatant liquor became of a pale blue. This liquor was supersaturated with muriatic acid, and a bar of zinc placed in it, which threw down 0.20 gr. of copper. The beforementioned brown precipitate, treated with an alkaline lye, left 2 gr. of oxide of iron. Muriate of ammonia poured into the alkaline solution, precipitated 5.5 gr. of alumine.

From these experiments it appears that the hepatic quicksilver ore of Idria contains 81.8 of quicksilver, 13.75 sulphur, 2.3 charcoal, 0.63 silica, 0.55 alumine, 0.2 oxide of iron, 0.02 oxide of copper, 0.73 water and loss.

The quicksilver being combined with the sulphur in the same proportion as in cinnabar, shews the fallacy of the opinion of Sage and Kirwan, that only part of the quicksilver is combined with the sulphur, and that the other portion is only oxidized. The latter ought to be soluble in nitric acid, which has however no effect upon the ore. They were probably led to this opinion by the decomposition which takes place when the ore is distilled per se; but this decomposition is effected by the charcoal. For when artificial cinnabar was distilled with lamp black, the greater part of the cinnabar was decomposed, and yielded a mixture of ethiops mineral and quicksilver.

Mr. K. imagines, however, that the quicksilver contained in cinnabar is slightly oxidized, because the metallic base, like all other in their lowest state of oxidizement, is incapable of solution in nitric acid, and also that the preparation of artificial cinnabar in the dry way, is always attended with inflammation, which appears to indicate oxidizement.

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*On the Insufficiency of Boiling, for the Purpose of separating Oxygen from Water. By Dr.* CARADORI.—*Jour. de Phys. Juin* 1806.

HUMBOLDT and Gay Lussac, in their memoir upon the methods used in eudiometry, are of opinion that boiling is the most efficacious method to deprive water of the oxygen contained in it. They observed that the proportion of oxygen that was expelled increased as the heat increased; but it appears that although boiling deprives water of a great part of the oxygen, or other aeriform fluid it may contain, yet the power of the caloric at the boiling point is not sufficient to overcome the attraction of the last portion of the oxygen, so that some part of it remains behind.

Let water be poured while boiling, into a bottle, so as to fill it, and a little oil be put upon the surface to prevent the access of

the air. If when cold the oil is removed, a small fish introduced into the water, and this latter immediately re-covered with oil, we shall nevertheless see the fish respire, and live for some time. Hence the boiling did not separate the whole of the oxygen.

On the other hand, if snow, ice, or hailstones be carefully melted, and oil poured over them as soon as possible, to prevent the access of air, till the whole has acquired the temperature of the atmosphere, the most lively fish will (on being immersed in this water after the oil has been removed) immediately fall into convulsions, and die in a few seconds. Hence it is evident that congelation is the most efficacious method of separating oxygen from water.

A fish immersed in common water, which is afterwards covered with oil, will live for some hours, but when it has absorbed all the oxygen it dies. If the oil be removed, and another fish introduced, it immediately dies. It therefore appears that fishes are capable of absorbing the whole of the oxygen which is contained in water.

Water which has been deprived of its oxygen by congelation, or the respiration of fishes, may be again impregnated with it, by exposure to air in a wide vessel.

There is no difference in this respect between melted ice or melted snow, as they both are entirely free from oxygen. Humboldt and Gay Lussac are of opinion that water in freezing separates a great part of its oxygen, mixed with azote, but when converted into snow, that less air is separated, because they found that snow in melting yielded nearly double the quantity of air to what ice did by the same process. This fact Dr. C. remarks is certainly true, but in neither case was the air expelled combined with the ice or snow; it was merely interposed; and as the interstices in snow are more numerous, it is not to be wondered at that it yields more air.

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*Description and Use of a Calorimeter. By Mr.* G. Montgolfier. —*Jour. des Mines,* No. 109.

It being of importance to discover the comparative power of different fuels in heating bodies exposed to their action, Mr. M. has invented a calorimeter for this purpose, founded on the principle of observing the degree of heat they can impart in a given space of time, to the same bulk of water, in the same vessel. For this purpose a determinate quantity of each kind of fuel is made to burn in a small stove, totally immersed in a vessel of water, and a tube proceeding from this vessel encircles the chimney of

the stove, which is carried out horizontally, in order to detain as much as possible of the heat.

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*Observations.*—The observations of Wedgewood, relative to the inconveniencies of Lavoisier's method of estimating the heat given out from bodies in the act of combustion, by the quantity of pounded ice well pressed together, that they will melt, and which are principally produced by the capillary attraction of the pounded ice, evidently point out this as a far preferable method.

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*On a new Principle in meteoric Stones. By* A. Laugier.—*Ann. de Chim. Juin* 1806.

All the chemists who had hitherto analyzed the stones which have fallen upon the earth, have obtained the same results, viz. silica, iron, magnesia, sulphur, nickel; and sometimes they have found traces of lime and alumine. But lately, Mr. Proust has announced the existence of manganese in such of these stones as he examined: this fact has since been confirmed by other chemists.

Mr. L. commencing his analysis of the stone which fell at Verona in 1663, by treating it with purified potash, supersaturating the solution thus obtained with nitric acid, and adding newly prepared nitrate of quicksilver ad minimum, obtained an orange red precipitate, which was found to be chromate of quicksilver. This chromate was decomposed by heat, and yielded green oxide of chrome in the proportion of $\frac{1}{100}$ of the quantity of stone examined.

The same oxide was found in the stones which fell at Ensisheim, at l'Aigle, at Barbotain, near Bordeaux, and lately at Apt; so that it is probable all the stones which have fallen upon the earth contain this principle.

It is also evident that it is perhaps indispensably necessary, in order to arrive at perfection in chemical analyses, to treat the same substance not only with acids, but also with alkalies; the present discovery shewing that a principle which is not found by examining a substance in one of these ways, may, nevertheless, be discovered by the other.

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*Observations.*—In addition to the disputes which have, as we have seen, lately arisen as to the analysis of sparry iron ore, the difference between calcareous spars and aragonite, and the presence of fluoric acid in the enamel of human teeth, the present paper evidently shews us upon how slight a foundation the boasted accuracy of modern chemical analysis rests, even in the hands of the most expert artists.

*On Alicant (or Tent) Wine, and the Grape that produces it. By Dr.* Pissis.—*Ann. de Chim.* No. 169.

It is commonly supposed, on account of the taste, that Alicant wine was boiled before it was fermented; but it is certain that the must itself was coloured. The colouring principle of the raisin is suspended in the juice, whereas that of other grapes is only soluble in alkohol, and is taken up as the must ferments. It is, however, the same as that of all red fruits, being of a blue colour, changing into red by acids, into green by alkalies, and decomposed by bodies communicating much oxygen.

Dr. P. having given some unadulterated Alicant wine to a patient, was surprised to find violet pellicles brought off the stomach, as though that organ had been gangrened, but which had an acid taste. By mixing all the liquids taken by the patient in various manners, he discovered that the alarming pellicles were in fact produced from the mixture of Alicant wine with the meat broth the patient had taken.

No other kind of wine yielded a precipitate when mixed with meat broth, nor even many of those sold for Alicant wine. The juice of the Alicant grape did not afford a similar precipitation until it was fermented. From this precipitation it is evident that the Alicant grape contains tannin, the meat broth being chiefly a solution of gelatine. The non-precipitation of the crude juice is occasioned by the suspension of the separated matter in the liquid from its viscosity. Although tannin is the agent in this precipitation, the precipitate itself is principally composed of the colouring matter which was previously combined with the tannin. It is the yellowness of the tannin that gives an orange tint to Alicant wine; on precipitation, it changes to violet, because the malic acid that remains no longer reddens the colouring matter; it would even become more blue, if it did not retain some tartar.

It is remarkable that the tannin does not give Alicant wine a bad taste, especially as wine in general is entirely spoiled in new oak casks, and requires the addition of a considerable quantity of isinglass to separate the tannin, and restore the flavour. But this, no doubt, is occasioned by fermentation, since we know that when must is fermented in a new oak vessel, it does not acquire any bad flavour.

We have now more certain marks to know the true Alicant wine. It has a red colour, slightly inclining to orange, a saccharine and spirituous taste, leaving a bitter after-taste, which is rather austere. It precipitates gelatine.

*Description of the Automolite. By Mr.* EKEBERG.—*Neue Allgem. Journ. der Chemie,* 1805.

THIS fossil is dark green in thin pieces; when held to the light some parts are dark green, others are blue-green. It is only found crystallized in tesseræ, either regular octaedrons, segments of octaedrons, or transposed octaedrons. They agree in form with those ascribed by Hauy to spinelle or pleonast; so that one might at first suppose this mineral to belong to one of those species, did not a more accurate inquiry show the contrary. The crystals are very small, their diameter being from 1 to 5 lines: some have been found of the size of small hazel-nuts. The fracture parallel to the faces of the octaedrons is perfectly foliated; the cross fracture is uneven, and rather conchoidal; the appearance of the fracture is glassy. The entire crystal is opake; the fragments are semitransparent at the edges. It is harder than quartz, and scratches that stone. It yields a light green powder, which, by farther trituration, becomes of a light gray colour. Its specific gravity is 4.261; that of a crystal mixed with talc was 4.1777, and another with small cubes of galena was 4.3714.

It is unfusible by the blowpipe, but its colour becomes rather deeper. By the help of oxygen gas upon charcoal, it undergoes a commencement of fusion, as the corners of very small fragments are rounded, without losing its colour, or degree of transparency. Borax dissolves it, and forms with it a clear glass, which is greenish when hot, and loses its colour when it cools. Microcosmic salt also dissolves it, but with difficulty, and forms a colourless glass. Soda does not attack it. It contains alumine 60.0, oxide of zinc 24.25, oxide of iron 9.25, silica 4.75, with some traces of oxide of manganese and lime, 1.75 being unaccounted for; so that Hisinger considers it as zinciferous corundum.

Mr. E. observes that circonia is supposed to be insoluble by fusion with microcosmic salt, but that, by perseverance, it may be made to dissolve in it.

*Observations.*—From the quantity of zinc which it contains, this mineral ought rather to be classed as an ore of zinc.

*On the Datolite. By Mr.* DELAMETHERIE.—*Jour. de Phys. Juin* 1806.

MR. Esmark has discovered at Arandahl, in Norway, a new mineral, to which he gives the name of datolite: according to

the analysis of Klaproth, it contains silica 36.5, lime 35.5, boracic acid 24, water 4; so that it appears to be a borate of lime combined perhaps accidentally with silica.

Its colour is white, more or less mixed with green. It is found in large masses, and in rectangular prismatic crystals, two of whose sides are broader than the other, terminated by obtuse summits, with four planes set upon the lateral edges. It is not foliated, but imperfectly conchoid, with small cavities, and glimmering. It is composed of large, granular, distinct concretions, which are coherent, but distinct; their surface has a very weak brilliancy. It is not quite so hard as felspar, semitransparent, or only translucid. Its specific gravity is 2.98.

By the blowpipe, upon charcoal, it puffs up into a milk-white mass, and at last yields a pale rose-coloured glass. It dissolves in cold nitric acid, a residuum of silica being left behind.

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## *Description of a new Apparatus for the Distillation of Wine. By Mr.* Julia.—*Ann. de Chimie*, No. 174.

Languedoc has always been one of the most considerable wine countries, and it is well known that in the 13th century Arnaud de Ville Neuve, a chemist of Languedoc, invented the distillation of wine. Since the late revolution, the quantity of land which has been broke up, and converted into vineyards, has so lowered the price of wine, that the manufacture of brandy is extended to the smallest villages. Some of the distillers, possessing very ingenious apparatus for this distillation, are enabled to undersell their brethren; and Mr. Adam has invented a process so very economical, that it is to be feared that many families will be ruined by him. The present apparatus, although it may not be equal to Mr. Adam's, is, however, far superior to that generally used.

The low stills constructed upon the plan of Mr. Chaptal, have this inconvenience, that when the fire is brisk, the wine itself frequently passes over along with the brandy; so that it is necessary to increase the height. The apparatus may be considered either as two stills and a worm-tub, or as a still with two worm-tubs—the former seems most convenient.

The first still is set in a convenient furnace, and is furnished with a feeding-pipe and a discharging cock. The second still, furnished also with a feeding-pipe, is placed by the side of the head of the first still, so high up that the discharging cock of this second still opens into and serves to replenish the first still. The swan-neck head of the first still is inserted into a worm, which first passes through the body of the second still, and is then continued to the proper worm-tub, placed under the second still.

The second still is covered by a low head, with a tube inserted into the worm at the place where it enters the worm-tub.

When the apparatus is used, the first still is filled to $\frac{3}{4}$ of its height with wine; the same quantity, and $\frac{1}{4}$ more, is poured into the second still. The distillation is then carried on, and when that in the first still is finished, the residuum is drawn off, and the still again filled with hot stuff from the second still, by turning the cock which forms the communication between the two. It having been found by experience that the wine in the second still loses $\frac{1}{5}$ during the distillation of that in the first still, what remains will, of course, form the proper charge. The second still being then filled with cold wine, the distillation is continued. By this apparatus, therefore, no stoppage takes place in the distillation by the new charge requiring to be heated, and thus a very great saving is made in the fuel.

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*On acetous Acid, and acetous Ether. By Mr.* GEHLEN.—*Ann. de Chim.* No. 169.

SCHEELE announced that acetous acid did not form ether, unless a mineral acid was also present. Schultz has shewn that this assertion is true; and Lichtemberg and Gehlen have repeated his experiments, and have found them to be exact; but the acetous acid must be so pure that the acetate of silver, or of barytes, is not affected by it, as a minimum of sulphuric acid is sufficient to determine the production of ether.

When equal quantities of acetous acid, and of alkohol, which had been rectified over melted muriate of lime, were mixed together, they did not acquire any increase of temperature; and on distillation no gases were emitted, nor was any residuum whatever left in the retort.

The acidity of acetic acid is not, within certain limits, in the direct ratio of its specific gravity: an acid crystallizing at a low temperature, whose specific gravity was 1.055, and which was obtained from well-dried acetate of soda, by concentrated sulphuric acid, saturated much more alkali than another acid whose specific gravity was 1.075, and which was obtained from the acetate of copper by concentrated sulphuric acid.

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*On the acetic Acid. By Mr.* J. B. TROMSDORFF.—*Ann de Chim.* No. 173.

IT is surprising that Mr. Proust should have found ammonia, or prussic acid, in the acetates, considering the knowledge we have already acquired as to the elements of ammonia and of the

vegetable acids. Indeed, if the acetates yield ammonia on distillation, they must contain azote; which azote does not proceed from the alkaline basis, because, according to Proust, it is also furnished by the acetate of lead, so that we should be obliged to allow it comes from the acid, or that the azote is only a modification of hydrogen.

The utmost precaution was therefore taken to procure the acetates of soda, potash, and lead, in the purest state, and they were separately distilled. The products were an ethereal acidulous liquor, mixed with oil; the alkalies and charcoal were left in the vessel when the alkaline acetates were used, and in the distillation of acetate of lead only an oxide of lead was left behind. And, of course, it appears that the predisposing attraction of the alkalies for carbonic acid determined the decomposition of the acetous acid; but the oxide of lead not having so great an attraction for carbonic acid, let the acetous acid separate itself without decomposition. It is still doubtful whether the metallic basis gives up the oxygen to unite with the carbone, or whether the attraction between an oxide and an acid is less forcible than between an acid and an alkali.

The gaseous products did not exhale any ammoniacal odour, but were simply empyreumatic and penetrating: all the liquids had the same smell, and no ammonia could be discovered in them.

Mr. Proust says the residuum of acetate of potash is partly prussiate of potash and partly carbonate of potash; but it is, in fact, only a homogeneous charcoal, which neither yields ammonia nor prussic acid, nor has it even the odour of those substances. As Mr. Proust says the residuum is so far saturated with prussic acid as to have a very sensible bitterness, it is most probable that he used an acetate made with common vinegar.

The vapours of acetous acid were passed through an ignited earthen tube, but its nature was very little changed; with an iron tube it was decomposed into carbonic acid gas, carburetted hydrogen, and a small quantity of empyreumatic liquor: neither ammonia nor prussic acid were obtained, nor were they found in the residuum.

The ethereal liquors mixed with oil were rectified upon carbonate of potash, and yielded a true acetic ether.

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*On the Use of Lichen Islandicus as Food. By Mr.* Proust.—*Ann. de Chim.* No. 170.

The lichen islandicus is a plant that furnishes so excellent a dish, and is so nourishing, that is deserves to be adopted as a kitchen herb.

One pound of the dry plant yields 3 lb. when boiled and drained, which may be eaten with butter, or in other methods. Its substance is purely membranaceous; it contains neither ligneous parts nor threads, which renders it very agreeable between the teeth. Although very elastic, after being boiled, it contains no animal matters, but affords the same products as sugar.

One pound of the dry plant will also furnish as much as 8 lb. of soup, which, on cooling, becomes a jelly: this soup is rather bitter, but not more than weak endive soup; by seasoning this soup with sweet and bitter almonds, citron peel, and sugar, it becomes very pleasant. The gelatinous substance appears to resemble that of fruits, rather than gum.

From these qualities Mr. P. is of opinion that nature has not produced a plant which is more fit for food.

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*Observations.*—The lichen islandicus has been lately introduced into this country as a medicinal food in consumptions. Although very common in mountainous countries, yet, as it is not, perhaps, cultivable, it does not seem ever likely to come into general use.

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*On human Hair. By Mr.* Vauquelin.—*Ann. de Chim.* No. 172.

Hair yields, on boiling in water, for several days, only a slight trace of animal matter; but it may be dissolved in water, by using a digester, and carefully managing the heat so as not to decompose the hair: whether the hair be decomposed or not, much sulphuretted hydrogen is disengaged, which blackens the copper vessel.

When black hair has been dissolved in water, there remains a black matter, which slowly subsides in the liquor, and is composed of a black thick oil, slightly soluble in alkohol and in the alkalies, of iron and of sulphur. Red hair left a yellow red residuum, of nearly the same nature.

The solution of hair has scarcely any colour; weak acids produce no change; but when concentrated, they render it turbid: an excess of acid restores the transparency. Infusion of gall-nuts, and oxigenized muriatic acid, produce much precipitate. Silver becomes black in it: acetate of lead is precipitated of a brown colour. On evaporation, the solution does not yield any jelly, but only a sticky gluey substance. When the hair was decomposed by the heat being too violent, acids produced more abundant and higher coloured precipitates.

Hair is soluble in a ley containing 4 per centum of potash. During this solution, hydrosulphuret of ammonia is disengaged; black hair left a thick oil, iron, and sulphur; red hair left a yellow oil, containing sulphur and a trace of iron. Acids produce

a white precipitate in this solution, which is resoluble by adding more acid; after which redissolution the solution in time became covered with an oily iridescent pellicle. The alkaline solution precipitates lead of a black colour, on account of the sulphur which it contains: when the sulphur is separated by exposure to the air, the solution lathers, and smells like that of soap.

Sulphuric acid poured upon hair, becomes of a very fine rose colour, and dissolves it.

Muriatic acid has the same effect.

Nitric acid turns the hair yellow, and dissolves it by the help of a slight heat. A black oil swims on the surface when black hair was used, and a red oil when red hair was used: both these oils become white at last, and grow solid on cooling. The solution being evaporated yields a considerable quantity of oxalic acid, and the residuum contains the bitter substance, much iron, and sulphuric acid, arising from the sulphur in the hair. The solution of red hair contains less iron, but more sulphur than black hair.

Oxygenized muriatic acid gas bleaches hair, and afterwards softens it, and reduces it into a viscous, transparent substance, like turpentine. This matter is bitter, and partly soluble, both in water and in alkohol.

Distilled by a naked fire, hair yields the same products as other animal matters; only it yields more sulphur, and very little gas: it leaves from 23 to 30 per centum of charcoal.

By incineration, black hair yields some iron and manganese (which give a brown-yellow colour to the ashes), phosphate, sulphate, and carbonate of lime, a little muriate of soda, and a quantity of silica: but the whole of the ashes does not amount to above $1\frac{1}{2}$ per centum. The ashes of red hair contain less iron and manganese, and those of white hair still less, but they contain phosphate of magnesia.

Alkohol extracts two kinds of oil from black hair, one of which is white, which falls down, on cooling the solution, in small brilliant plates; the other, which is separated by distillation, is greenish-gray, and also becomes solid by time. Red hair also yields a white concrete oil, and another oil separable by distillation, of a blood-red colour: the residual hair becomes of a brown or chesnut colour.

It is easy to perceive the chemical difference between the different coloured hairs; in all hair sulphur appears to be contained in excess, and probably united to hydrogen, as the white metallic oxides are soon turned black when applied to hair.

The sudden rendering of the hair gray by grief or fear is ascribable to the production of an acid which decomposes the colouring matter of the hair; but the grayness of the hair brought on by age is owing to a defect in the secretion of the colouring matter.

The basis of the hair is neither gelatine nor albumen, but mucus or animal mucilage. The humour secreted in the plica Polonica is of the same nature as the hair itself, and that disease appears to be in fact a superabundant secretion of the matter of hair.

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*On the Decomposition of Water, and the Substances it holds in Solution, by Galvanism. By* C. I. T. *de* GROTTHUSS.—*Ann. de Chim.* No. 172.

WHEN the galvanic fluid is passed through a metallic solution, oxygen is disengaged from the wire in contact with the positive end of the pile, and the metal is revived and deposited in an arborescent form at the other end, the branches extending towards the positive end in the current of the galvanic fluid. All metallic solutions are not decomposed by the galvanic fluid, nitrate of manganese, for example; and indeed it appears that when the metal has a greater attraction for oxygen than hydrogen has for that principle, it is the water that is decomposed, and hydrogen is emitted from the negative or copper end of the pile.

When the metallic vegetation is extended to within a small distance of the other wire, its further progress ceases. By the two wires being brought very near together, they seem to acquire the electric fluid from one another, so that the metal deposited on the wire begins to become oxidized, while at the same time a disoxygenizement takes place at the positive wire. It is also probable that when the two wires are very fine, and placed very near together, the gases arising from the decomposition of the liquid are emitted in a mixed state, as in the decomposition of water by the common electric machine.

When the galvanic fluid acts upon water, or any solution, the positive wire attracts the oxygenizing principle, and the negative wire attracts the oxygenized principle. If the proportions of the liquid can be changed, it becomes oxygenized at the end of the positive wire, and disoxygenized at the end of the other wire. By counter-changing the position of the wires, each part of the liquid will return to its primitive state, and then another change will take place in an inverted order. But it appears very difficult to explain why in decomposing water by the galvanic fluid, hydrogen only is separated at the end of one wire, and oxygen at the end of the other. Mr. G. endeavours to explain it in the following manner:

The galvanic pile is an electrical magnet, in which each pair of discs possesses its own positive and negative pole. Suppose then that at the commencement of the separation, which is about to take place between the hydrogen and oxygen, their natural elec-

tricity is so divided that the hydrogen acquires the positive, and the oxygen the negative electricity; it will follow that the hydrogen will be attracted, and oxygen repelled by the negative wire, and that oxygen will be attracted, and hydrogen repelled by the positive wire.

When therefore a current of galvanic fluid is passed through water, the molecules in the course of it, form as it were the *complement* of the pile, and being moveable, all the particles of oxygen will have a tendency to go towards the positive wire, and those of hydrogen will tend the contrary way. At the same time therefore that the molecule of water which is in contact with the positive wire, is obliged to part with its oxygen to the wire, it will be immediately re-oxygenized by the oxygen from the next molecule of water in the direction of the current, and so on throughout the whole extent of the communication: the same operation, but in an opposite direction, takes place in respect to the hydrogen, which is abstracted by the negative wire from the molecule of water in contact with it. According to this hypothesis, it is only the two molecules of water in immediate contact with the wires that are permanently decomposed, all the others situated in the current of the fluid being recomposed as fast as they are decomposed.

The same polar arrangement takes place in other liquids exposed to the galvanic fluid.

From the above explanation it appears that no extra proportion of hydrogen can be accumulated in the part of the water next the positive wire, nor can any oxygenizement take place in the neighbourhood of the negative wire. The production of acid by the positive wire, and that of alkali by the negative wire, is agreeable to this theory, since one may be regarded as caused by oxygenizement, and the other as caused by hydrogenizement.

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*On a Head cut in Flint, with a Coating of Chalcedony. By Mr.* Guyton —*Ann. de Chim.* No. 172.

In the Faubourg du Roule was found, about four months ago, a head cut in flint (probably very ancient), which appeared to have belonged to a statue of about 63 centimetres (2 feet) high. Every part of this head which was not broke nor rubbed, was covered with a very thin coating of a fine white colour, not attacked by acids, and which was at least as hard as chalcedony, while at the same time it had the glassy appearance of an enamel, sufficiently thin and translucid to let the different shades of colour in the flint be seen.

It was at first thought that the statue, after being sculptured, had been glazed artificially by fire, especially as two fractures

were covered with a dull white crust, manifestly formed since the statue was buried in the ground; but it was found that flint loses its colour and transparency in a heat that will not even melt feldspar; whereas the flint of which the head is formed is perfect in all its characters in those parts that were exposed by some more recent fractures.

Although flint is usually encrusted in its natural state, the crusts are always dull, and without any glossy appearance; nor is it likely that the polished surface given to the flint would have caused the chalcedony to assume this form, because the chalcedony which is found encrusting crystallized minerals of the most smooth surface, is always dull.

Two specimens of minerals, however, have been found, which in some measure approach to the appearance of the head. One was found in the department d'Indre-et-Loire; it appeared to be entirely covered with white chalcedony, but on being broken, it was found to be the same throughout, and had merely acquired a polished surface by rubbing. The other was found in Siberia; one of its surfaces had something of the appearance of a polished vitreous enamel; it was, however, only an opake white chalcedony upon another, which was more transparent. It was also traversed by two reddish lines, which crossed each other in different directions.

Although, as is said above, flint is soon altered by heat, yet as it seemed possible that cementation in a moderate heat, or long digestion in melted salts, or solutions of earths, might be more successful, the following experiments were made:

Flint cemented in lime, gypsum, alum, or common salt, was not altered, unless the heat was considerable, and then, as usual, it lost its colour, transparency, and cohesion.

Flint was not altered by purified potash in a heat just sufficient to melt the latter, but it was very slowly dissolved.

Flint was treated with a solution of potash saturated with alumine, to which some more potash was added to act in some degree upon the flint in a platina crucible, in a degree of heat incapable of altering the flint. In another experiment, a little lime was added to the mixture. In both these experiments the flint was not altered in the interior part, but it had acquired a very thin white coat, of an uniform thickness, not attacked by acids, and so hard that it wore down the engraving tools very fast, and was as difficult to scratch by corundum as the chalcedony that covered the head. The coating was indeed dull, but it was susceptible of the same polish as the other.

Mr. Chaptal, however, still thinks that the chalcedony that covers the head is the effect of its being buried, and has shewn some specimens of flint found in the same neighbourhood, which have in some parts a coating equal in lustre, if not in colour or thickness.

Mr. Fourcroy thinks, that whether the chalcedony has been formed by art after the head was sculptured, or is the effect of its being buried, still it must have been polished since that crust was formed.

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*Observations.*—The above-mentioned experiment in which flint was artificially covered with a coating of chalcedony, seems to be of some importance in the arts, and certainly merits a further inquiry.

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## *On the Oxidizement of Metals, and particularly on that of Lead.* By Dr. Delaville.—*Ann. de Chim.* No. 172.

Lead shot agitated in water renders it turbid, and of a slate-gray colour; by continuing the agitation the suspended particles become of a grayish colour, then whitish, and lastly of a very fine white colour.

This oxide, when taken out of the water, and exposed to the air, becomes covered almost instantaneously with a pellicle of the purest white colour, which appears to be carbonate of lead.

While kept under water, it undergoes no alteration, either by light or darkness; but if kept on along with a small quantity of water, in a large bottle, those parts of it which stick to the sides of the bottle above the surface of the water, when exposed to the light or to heat, become first yellow, and then red.

To obtain these oxides for the purposes of painters, &c. Dr. Delaville uses a leaden barrel turning upon its axis, containing about one fifth of water, and a certain quantity of shot, which is continually agitated in it. The free access of air is provided by soldering tubes so as to admit the air, but not allow the water to escape.

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*Observations.*—We have great doubts whether the saving of fuel consumed in the usual mode of manufacturing red lead, and the oxides of lead, would not be more than compensated by the superior labour required in Dr. Delaville's process.

# REVIEW OF SPECIFICATIONS OF PATENTS,

PUBLISHED IN THE REPERTORY OF ARTS, &c. IN THE MONTHS OF JULY, AUGUST, AND SEPTEMBER, 1806.

*Mr.* DAVID HARDIE'S *Patent for the Improvement of an Apparatus for Weighing. Dated March* 1800.—*Rep. Arts,* No. 50, *New Series.*

THE essential part of Mr. Hardie's improved apparatus consists in his manner of forming the weights, of disposing them on the scale-board, and of indicating at sight the aggregate weight of the articles in the other scale. A peculiar kind of estimating scale is delineated on that scale-board which receives the weights, so as to point out by mere inspection the total of the weights placed upon that board. These scales, as well as the shape of the weights, are modified according to the various cases to which they are applied. Thus the board for the weights capable of estimating as far as a ton, is about 38 inches by 32; and upon it are delineated two scales, each formed of rectangular compartments: one contains larger divisions for the half-hundred weights, and the other contains smaller divisions for the pound weights. The larger weights are placed on their respective scale of rectangles or squares, beginning at the left side and ranging orderly to the right, and so on with each row, five occupying a row. The first hundred weight, or rather the first combination of two half-hundred weights, constituting a hundred weight, covers a blank square; the second, a square marked 1; the third, that marked 2; and so on. The pound weights, in like manner, are placed on their particular scale of rectangles, ranged below these for the hundred weights, the first weight covering the blank rectangle; the second, that marked 1; the third, that marked 2; and so on, proceeding likewise from the left towards the right. There is no scale for quarter-hundred weights, they being at most 2 in number, namely, a half, and a quarter hundred weight. The totals of the hundreds and pounds are indicated by the large figures painted on the board, that appear respectively next to the weights on the right hand. Hence it follows that the amount of the weights on the board in hundreds, quarters, and pounds, is accurately known, without the trouble of counting, by mere inspection; and that the book-keeper has it in his power to dis-

over with a glance, whether the weighers call the proper weight. The greatest individual weight for the purpose of being portable, is a half-hundred. The weights are ingeniously formed, so as to be readily moved, at the same time that they may be accurately disposed in rows.

When a very light package is to be weighed with a board adapted for one much greater, a hook and eye are to be used at each of the two cords suspending the board for the weights, in order to shorten them, and prevent the board from leaning to one side. Where a chain, instead of a rope is used, one of its links might serve as an eye to the hook.

On the same principle the scale or scales which determine the total weight on the board, as well as the shape of the weights, may be modified according to the various cases to which they are applied. In the observations given by the patentee, in addition to his specification, in the Repertory of Arts, &c. No. 50, these modifications are illustrated by other examples. Figures are likewise given with the specification, exhibiting certain well-adapted apparatus, to prevent the necessity of removing the greater number of weights from the scale-board on each operation, varied to suit different situations, and different sizes of commodities to be weighed.

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*Observations.*—Every person who has experienced the numerous errors to which the common method of weighing heavy and cumbersome substances is liable, must rejoice at the publication of a simple, ingenious, and convenient apparatus, by means of which those errors may be obviated, and all the operations of weighing performed with greater expedition, yet with all possible accuracy. The advantages of mere inspection over a tedious examination, and counting of different weights with obscure marks, are too obvious to need enlarging upon: we therefore think it our duty to recommend this useful apparatus to general adoption in all extensive concerns, whether national or commercial, where there is a frequent necessity for ascertaining the weight of ponderous articles, such as pigs of lead, bars of iron, pieces of ordnance, hogsheads of sugar, bales of goods, &c. We see only one way in which this apparatus can be at all accessary to fraud or deception; namely, in the distribution of the pound weights, which *may* be so placed as to skip some of the rectangles on the scale, and thus make the apparent weight in pounds, exceed the true weight: but this is a source of deception which may always be checked with a very moderate share of vigilance on the part of an overseer or book-keeper; besides that there are comparatively few cases in which the labourers employed in arranging the weights will be exposed to the least temptation to practise such a fraud.

*Rev.* William Milton's *Patent, for a Mode of rendering Carriages, particularly Stage-coaches, more safe than at present. Dated Nov.* 1805.—*Rep. Arts,* No. 51, *New Series.*

The principal objects of Mr. Milton's invention are to prevent the overturning of coaches, and their breaking down. To effect these desirable purposes, the patentee fixes beneath the body of the carriage, a box (nearly equal in length and breadth to the bottom of that body) capable of receiving the luggage, and with its floor about a foot from the ground. The luggage being disposed in this box, reduces the centre of gravity of the coach, and its load to a much lower position, and of consequence renders an overturn less likely than in the common construction.

There must often be a cavity through either the lower part of the carriage or of the luggage-box, through which the axle and frame-work of the hind wheels of the carriage may pass. This cavity and axle are to be such as shall give proper guidance in the play of the carriage and luggage-box on any springs that may be so applied as to need such guidance. But springs may be applied in such a manner as to require no such guidance. At the bottom of this luggage-box, and as near respectively to each wheel of the carriage (called by way of distinction, *active* wheels) as may be deemed proper, low strong wheels (called *idle* wheels) are to be placed on sufficient axles, ready in case of an active wheel coming off, or an axletree failing, to catch the falling vehicle, and instantly to continue the previous velocity: whence the mischief, particularly to the coachman and outside passengers, arising from an instantaneous stop to rapid motion, will be prevented. These idle wheels are to be placed so that their periphery shall be a few inches below the bottom of the luggage-box, and (when the active wheel is in motion) a few inches above the ground. If there be no luggage-box below, then the idle wheels may be larger, and fixed to the axle, or to some frame-work belonging to it; and in case of the breaking, or coming off of a wheel, great relief will be given. If there be an obstacle in the road, and the idle wheel comes into contact with it, its corresponding active wheel will be lifted from the ground, while the idle wheel passes over the obstacle.

The bottom of the luggage-box being in this construction so near the ground, offers a method of checking very much the motion of a carriage down a hill, by the strong and ready application of the end of a lever to rub on the ground. The idle wheels should be fixed or set in such a manner that they may be vertical when an accident brings them into work.

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*Observations.*—Such are the simple and ingenious modifications in the construction of carriages, by which Mr. Milton adds to their

safety and utility: if we consulted the eye alone, we might, perhaps, object to this patentee's improvements; but that of placing the luggage-box beneath the carriage is consistent with the strictest theory, at the same time that it gives facility to the application of the other improvements. Some experiments have been made, before many witnesses, upon a coach of Mr. Milton's construction, weighing 18½ cwt. and carrying six inside passengers: there were ten outside passengers, and a load of nearly three tons: the coach was driven purposely over rough roads, and a linch-pin of one of the hind-wheels being taken out, the wheel came off, and the carriage dropped down about 7 inches, when a strong idle wheel came into play, and the motion was continued without the least inconvenience to the outside passengers, and no greater a shock than was experienced by going over a large stone in the night. The horses were not more than usually fatigued. Grounding a firm conviction upon these facts, and the theoretic propriety of Mr. Milton's construction, we cannot do less than warmly recommend it as worthy adoption by all proprietors of stage-coaches, &c. who are anxious for the safety of their passengers.

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*Mr.* William Sampson's *Patent for certain Improvements in the Application of Power employed mechanically, especially as adapted to the Use of Cranks and Fly-wheels, or other Contrivances producing equivalent or similar Effects. Dated February* 1806.—*Rep. Arts,* No. 52, *New Series.*

The proposed improvements of this patentee principally consist, according to the specification, in the division of any power which turns a reciprocating axis between two or more arms intersecting that axis, and communicating their motion to corresponding cranks, wheels, or other suitable contrivances, for the purpose of uniting to work one and the same shaft; the arms by this combined process transmitting to such shaft, with great advantage, the power impressed on them.

The *invention* described in the specification is simply this: Let a wheel which is divested of its rim, and of all its spokes, except four, that together form two diameters, at right angles to each other, be permitted to turn upon a fixed axle or pin: let an axis of rotation carrying a fly-wheel and two cranks be disposed at a suitable distance from the former wheel, and let two connecting rods be attached each by one end to the cranks, and by the other to the extremities of two opposite spokes of the wheel: then the other two spokes will serve as handles, by means of which such an alternating motion may be given to the

wheel as shall transmit a continued rotatory motion by the connecting rods to the axis carrying the fly-wheel. And if other connecting rods proceed from the cranks on this axis to cranks on another axis, a continued rotatory motion may in like manner be communicated to it also. Small machines may be worked by a handle suspended from an axis, and aided by a pendulum.

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*Observations.*—We are not able to conjecture what cause could induce Mr. Sampson to obtain a patent for these contrivances. The general principle by which he converts a reciprocating into a rotatory motion has been known for centuries, and has been applied to different kinds of machinery in the collections of Ramelli, Bockler, Bellidor, and Leupold: but the reverse method of applying the principle, so as to convert rotatory into reciprocating motions, is of far more general use. The principal mover of machinery that acts by alternating motion is man, whose mechanic energy is too much confined to be resorted to in extensive erections: and even the most powerful reciprocating action of man, viz. that which is after the manner of rowing, is not included in the examples of Mr. Sampson's specification. Hence we think this gentleman will be greatly disappointed, if he have formed any expectation of the general adoption of the contrivances he has now made public. Much more ingenious and useful applications of the same principle, are almost universally practised, where suitable occasions call for their adoption, by every skilful mechanist in this country.

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*Mr.* Martin Cawood's *Patent for an Improvement in manufacturing metallic Cocks. Dated May* 1805.—*Rep. Arts,* No. 50, *New Series.*

Instead of casting the cocks entirely of brass, or bell-metal, as is customary, Mr. Cawood forms them of cast iron, and covers with brass those parts of the piston and pipe which come in contact, by soldering, bruising, or cementing the brass to the iron.

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*Observations.*—We agree with the patentee in the statement which he makes of the advantages to be derived from his method of manufacturing cocks, that they will be much less liable to burst from change of temperature than common cocks; will wear longer, can be more easily repaired when worn, and be sold for half the price of cocks of the usual construction.

*Mr.* Henry Edward Witherby's *Patent for a Filtering Apparatus. Dated July* 1805.—*Repert. Arts,* No. 51, *New Series.*

This apparatus consists of a vessel closed at top, to hold the water, with a small pipe at bottom, by which it is filled (when reversed), and which also serves to convey the water from it to a flat vessel, which it keeps full of water to a certain height, on the same principle as a bird-fountain: from this flat vessel the water is conveyed to another containing the filtering part by sponges or pieces of flannel so placed as to perform the office of syphons; the second vessel has a layer of gravel at its bottom, covered over with flannel, above which is laid fine washed sand to the depth of three inches: a pipe is placed beneath the gravel to let off the clear water into a receiver.

*Observations.*—The adoption of an old contrivance for keeping water to a certain level, and the application of the flannel or sponge syphon, which has been used as a filterer from a very remote period, seem to be the only points in which this apparatus differs from others in general use, in which sand and gravel is used as a medium of filtration. But though we can see no novelty in any part of the principles of this apparatus, it may, however, filter very well, and have the advantages of quick performance, and of being easily cleaned, as stated by the patentee, and from these good qualities be very useful.

*Mr.* James Ingram's *Patent for a Method of manufacturing Powder Sugar from Raw Sugar, from Syrup, or from a Mixture of both. Dated Nov.* 1805.—*Repert. Arts,* No. 51, *New Series.*

For this process, Mr. Ingram directs that a pint of water, or of lime-water, be added to every seven pound of sugar to be prepared: that the sugar so mixed be boiled in an iron vessel, till some of it taken up in the stem of a tobacco-pipe, and dipped into cold water, breaks brittle, and can be taken from the pipe with ease: that it is then to be poured on an oiled marble slab, or other polished stone, and when it begins to harden there; is to be formed into rolls, which are to be worked and drawn by hand over an upright iron spike till the sugar whitens and becomes stiff.

The rolls are then to be baked in a stove, such as is used for drying lump sugar, for two days; and when they are quite dry, they are to be ground in a sugar-mill, with a large stone, or other

proper thing, into a powder: then sifted through a fine sieve, and afterwards returned to the mill, and mixed with a proportion of raw sugar, of 14 lb. to each hundred weight of powder sugar, when it will be fit for use.

In making powder sugar from syrup of sugar alone, the same process is used, except that no water is added; and likewise in making it from a mixture of raw sugar and syrup, equal parts of which are to be mixed together for this purpose.

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*Messrs.* Hobson, Sylvester, *and* Moorhouse's *Patent for the Application of Zinc to sheathing Ships, roofing Houses, and lining Water-spouts. Dated May* 1805.—*Repert. Arts,* No. 52, *New Series.*

The great art in laminating the zinc, from bars previously cast, is to keep it at a heat of between 200° and 300° Fahrenheit, while passing between the rollers, till it is reduced to one fourth of its usual thickness, after which it may be rolled to the thickness required without farther heating. The plates after rolling will be hard and stiff, but on being annealed at the heat before mentioned, will acquire the flexibility proper for roofing houses, sheathing ships, &c.; for which latter use iron nails are directed to be used with it, as copper nails would have a galvanic action on it.

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*Observations.*—Messrs. Hobson and Sylvester obtained a patent for rendering zinc malleable, in the month preceding the date of this patent, for which see our third Number, p 396. The object of the present patent seems to be, to secure the specific application of the zinc so manufactured, to sheathing ships, roofing houses, and lining water-spouts.

We have expressed our decisive approbation of the general application of zinc, in the Number above mentioned, and also in p. 51 of our first Number, and of the value of the discovery in a commercial view. We also approve much of its application to the roofing of houses here specified. It might be in the first place furnished cheaper, and would not communicate any of those noxious qualities to rain water collected from it, which lead and copper roofs always do. But we are sorry we cannot say any thing in favour of its use for sheathing ships. A great object of copper sheathing is to keep the ship's bottom clean, and free from the adherence of sea-weeds, and of various shell-fish, which attach themselves to most floating substances, as well as to prevent the destructive effects of the teredo, or ship-worm. We are certain that zinc sheathing would be still less injurious to animal and vegetable life than lead, to which, however, the various shell-fish and sea-weeds adhere almost as much as to wood; copper

itself is not entirely free from this inconvenience; though so much so, as to be vastly superior in this respect to any other substance known. How far zinc would prevent the perforation of worms is not so certain; some will penetrate lead, and those we think would find no difficulty in boring through zinc.

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*Mr.* JOHN TROTTER's *Patent for a rotary Engine, for applying the Powers of Fluids as first Movers. Dated November* 1805. —*Repert. Arts,* No. 50, *New Series.*

THIS rotary engine is constituted of five principal parts: 1st, A circular piece (cylindrical we suppose) called the outer barrel. 2dly, A circular concentric piece called the inner barrel. 3dly, A circular piece posited between the former, called the eccentric. 4thly, A piece called the sweep, which shuts completely across the space between the inner and outer barrels, so as to intercept the communication in that part. 5thly, Caps or covers at each end of the said pieces, which close the space between the two barrels, and serve, by grooves or other well-known fittings, to keep the other parts in their respective places.

The situations and motions of these parts are as follow: 1. The barrels are concentric. 2. The sweep is capable of moving or revolving (either by absolute or rotative motion) through the space between the barrels: it may be either separate from the barrels, or it may be fixed to either or both of them; and in the last mentioned cases, the barrel or barrels to which the sweep shall be so fixed will necessarily move along with it. The sweep is so well fitted or fixed, that no fluid can pass through the places of its opposition or junction with the barrels and caps, or as that the quantity suffered to pass shall be inconsiderable. 3. The eccentric is of such a diameter, and so wrought, that its concave and convex surfaces shall touch the inner and outer barrels, and that the places of contact shall not admit any fluid to pass between the eccentric and each barrel severally, or at least that the quantity which may so pass shall be inconsiderable. The eccentric is capable of rotation in its own periphery, but not otherwise with relation to the caps; and it has a long perforation through which the sweep is put, so that the sweep and the eccentric will always move together. The patentee thinks it manifest, from the nature of this construction, that if any fluid be forced by gravity, elasticity, or otherwise, through one or more apertures from without into the space on one side of the sweep, that pressure will carry the sweep forward and the eccentric along with it, together with such barrel or barrels as by the construction shall be fixed to the sweep; and moreover, if there be any one or more other apertures communicating from the opposite side of the sweep, in order to allow the said fluid to escape, or be carried off, or condensed,

or otherwise disposed of, all such portions of the said fluid as by the changes of situation of the sweep, shall be separated from occupying part of the space behind the sweep, and shall come to occupy part of the space before the same, will in fact so escape, or be carried off, or condensed, or disposed of, and the rotary motion of the engine will be kept up, and may be applied as a first mover to other works, so long as a due supply of the said fluid shall be afforded.

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*Observations.*—Mr. Trotter's specification is extremely defective; being inaccurate, inadequate, and contradictory.

The inaccuracy of language we should not notice if confined within common limits, or on subjects where exact definition was not important, as we should deem attention to such trifles fastidious hypercriticism. Mr. Trotter has in many parts of his specification used the word circular for cylindrical; he has declared that his engine consists of three *circular* pieces, which are to hold steam, or water, &c.; now a circular piece conveys only the idea of a flat surface which can contain nothing.

The description is contradictory in the part relative to the *sweep*; which first mentions "that it is to move or revolve through the space between the two barrels;" and then immediately after states, "that it may be *fixed* to *both* of them;" in which case it is obvious it could not move through the space between them: and we think that in this way the engine could have no motion whatsoever.

The inadequacy of the account of the engine is no less remarkable. A most material part is left totally undescribed in it, without which the engine would have no effect whatsoever as a prime mover. If the eccentric is to move round with the inner barrel, or the sweep alone, some part (of the nature of an axis) must pass through one of the caps to convey the motion to the machinery to be impelled by it; or if the said eccentric is to move with the outer barrel, then some piece, of a like nature, must pass through the cap, to keep the inner barrel fixed and motionless; but no such piece is described: and it required an effort little short of invention to discover how the engine was to move at all for want of any mention of this part. The manner of fixing the pipes to convey the steam to the spaces between the eccentric and the barrels, and away from them again, is also left undescribed, which we think a material omission; for as they must revolve round with the moving part, it requires another effort of invention to find out how two pipes are to revolve with a barrel, into whose side they are to pass, and communicate at the same time by *steam-tight joints*, with *two fixed objects*, the boiler and condenser.

In short, from the causes mentioned, the description is so defective, that we will venture to say very few who read it can un-

derstand how the engine performs at all, much less be able to make one.

The difficulty of the construction (after the labour of understanding the manner of it is surmounted) would be excessive; the contrivance of steam-tight joints for the two revolving pipes would be very hard to effect; the passage of an axis through the cap sufficiently tight would not be very easy to perform: the stuffing for the circular edges of the eccentric, and of the sides of he *long perforation* in it, as it is called, through which the sweep passes, would also require much management; but all these would be operations of facility compared to fitting the eccentric so as "that its concave and convex surfaces shall touch the inner and outer barrels" in such manner as to be steam-tight. If Mr. Trotter has discovered any way of producing this effect by stuffing, it was a material error to omit mentioning it; for without some such contrivance the engine would be altogether useless. We grant it lies within the limits of a bare possibility, that by an happy effort of accurate workmanship, the parts might be fitted at first so truly as to perform without stuffing. But after this miraculous nicety was produced, its effect could only be temporary; the wear of a few days (perhaps of a few hours) must open a passage for the steam, and soon after cause a cessation of motion altogether to the engine.

Reflecting on all these difficulties of construction, we find them approach so near the confines of impossibility, that we really doubt much if ever even a working model of this engine was made, so as to perform for any length of time.

And even when by a strong effort of imagination, we conceive such an engine brought in reality to perform work permanently and effectually, we think that still it would be liable to the same defects as Mr. Hornblower's rotative engine, described in our second Number, arising from the great friction of its parts, and this in a much greater degree than in his engine; as the surfaces coming in contact are so much greater.

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*Mr.* Bracy Clark's *Patent for Improvements upon Horse-shoes, by which they may be affixed to Feet without Nailing. Dated March* 1806.—*Repert. Arts,* No. 51, *New Series.*

The invention consists of two distinct shoes, but united to each other by means of screws: the upper or permanent shoe is attached by means of front and tabral clips or tongues embracing the foot, and to prevent the foot escaping backward, a bolt or pin passes through the front clip into the hoof, which bolt or pin is allowed to descend as the hoof grows downward, by means of a groove in the clip. This upper shoe may last for years, being

preserved from wear by the under shoe, and which is to be renewed as often as necessary; the under or wearing shoe may be made of common iron, and is easily yet firmly fixed by four or more screws passing from the upper or permanent shoe into it. The specification of the patent admits of various modifications, but the above are the general principles.

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*Observations.*—Mr. Clark has much credit due to him for prosecuting the original idea of his invention, which is certainly very ingenious; yet it can hardly be supposed that a shoe of this kind will ever be generally adopted; its advantages in many cases must, however, be very obvious. It is well known that the feet of horses become diseased in consequence of the artificial state in which they are placed, by our being compelled to employ shoes made of iron to guard them from the wear occasioned by our artificial roads, and this disease will be in proportion to the just or erroneous principles that are pursued. The closer we imitate nature the more successful will our practice be; and the invention of a shoe that will leave the horse's foot completely in a natural state, except during the hours the animal is at work, must be attended with manifold advantages: the occasional use only of such a shoe might often be found beneficial. Notwithstanding the advantages to be derived from Mr. Clark's shoe appear numerous, there are many circumstances that must tend to prevent its general use; and indeed, its merits will not appear so conspicuous as they would have done before the general practice of shoeing horses was so much improved as it has been by the attention paid to this subject within the last few years. We fear a new set of men must be employed in fabricating the patent shoes; for generally, the shoeing smiths of the present day can never be taught, neither will they give that ready assistance by paring the foot in a proper manner, which is so necessary to ensure success. The new set of persons to be employed must be familiarized to horses, and taught the method of paring a foot: for as no art can prevent the hoof growing, and as in its growth downward it always expands, it will be necessary from time to time and regularly to remove the superfluous growth of hoof, and not only of that but of the sole also. The expense too, may, perhaps, be a consideration, and the trouble of fixing and unfixing, although comparatively little, will always be started as an objection to its use.

*Mr.* Richard Willcox's *Patent for Machinery for cutting or stripping the Fur, Wool, or Hair, from the Skins of Beavers, Seals, &c. Dated Dec.* 1805.—*Repert. Arts,* No. 52, *New Series.*

The skin, whose fur is to be taken off, is made to adhere (by a cement made of wax, resin, and oil, with other ingredients occasionally) to a strong canvass cloth, which is fastened round a roller, made to turn slowly by a ratchet-wheel moved by a click, that receives a motion back and forward from a crank: a small roller, about three quarters of an inch in diameter, moves in front of the other roller, and presses back the fur out of the way of the knife, to prevent its being cut improperly. The knives are moved by levers, connected with the crank before mentioned, and by springs, so as to have a motion backwards and forwards across the skins, and are sustained by guides in a proper direction to the centre of the roller, to cut off the fur as it should be. A piece of Russia duck joined at the two extremities so as to form a perpetual web, drawn, by a connexion of rollers, round the small roller before mentioned, is pressed in contact with the skin, and moves with about double the speed of the skin in a contrary direction, which causes the fur to adhere to it in the same order in which it lay on the skin. This web afterwards passes over one of the leading rollers, where it is bent nearly to a right angle, so as to admit the introduction of a plate of metal as close as possible to the fur which adheres to it: by this means the long hair (usually plucked off by hand) comes in contact with the edge of the plate; whilst a roller studded with rows of locks of hair, of leather, or some other flexible substance (which moves in the same direction as the fur), scrapes off the long hair from the fur, by pressing it against the edge of the plate; whence it is conveyed into a trough, and prevented from again mixing with the fur.

For separating the long hair from the fur of those skins whose fur is too short to be separated in the manner described, the patentee has contrived another engine; in which the skin is fixed to a roller in the same manner as in the first engine, and which roller is also moved by a similar contrivance. A very small roller is placed in front of this first roller, so as to lie close to the fur, and a large roller (fluted in grooves formed in spirals of a very small inclination to the plane of its axis, and moving in the same direction as the first roller) catches the long hairs between it and the small roller, and plucks them from the skin.

The knives used by the patentee for cutting the fur are made of the best tempered steel, grooved or fluted in very small grooves

at the face side at right angles to the edge, by which the edge, when ground on the opposite side, is formed into a very fine saw, in the same way as a similar edge is formed on reaping-hooks; by which means the knives keep their edges at least twelve times as long as the common sort, which are made of malleable iron, to produce a rough edge, which is found to answer better for cutting the fur than a smooth one. The knives are also in general made circular (particularly when the machinery is moved by water or steam), by which a drawing stroke is produced, having more velocity than could be produced without rotation.

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*Observation.*—The above described is a very ingenious machine, and in practice we understand has fully answered the expectations of the inventor.

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## *Captain* Cowan's *Patent for Improvements in the Construction of Sails. Dated June* 1805.—*Repert. Arts,* No. 50, *New Series.*

The principal object of Mr. Cowan is to have sails so fitted up as to reef at the bottom instead of the top; in which parts they are to be furnished with points, gaskets, robins, buntlines, and the other tackle necessary for reefing one or more reefs, which do not in this case differ materially from those used for reefing at the top of the sail, or with buntlines, reeflines, and gaskets, alone. Mr. Cowan gives in his specification a very particular description of the whole process of reefing at the lower part of the sail with reeflines and gaskets only (see Rep. Arts, vol. ix. p. 83), but which being entirely in technical language, would be altogether unintelligible to any but seafaring men. The sails are also directed to be made with the clothes or seams horizontal, instead of in the usual vertical position, by which they will be much stronger in the opinion of the patentee.

The advantages stated to arise from the use of the patent method of reefing are, 1st, that the sails can be reefed thus in less time; 2d, with fewer hands; 3d, with less danger of splitting or starting the tacks or sheets; 4th, that the reefs at the foot of the sail will occasion less weight on the yard than those at the top; 5th, that the reef at the foot being at the squarest or broadest part of the sail will reduce its size more, and cause it to stand longer and better in a gale of wind; 6th, that as in the method of reefing with buntlines, reeflines, and gaskets, the points, bands, and eyelet-holes, of the old method will be unnecessary, the sails will thus be much lighter; so that the main-course of a seventy-four will be reduced in weight above two hundred pounds in this mode.

Mr. Cowan mentions in his specification an improvement contrived by him in fore and aft sails, for which he refers entirely to

the engraved figure, not giving any description of it whatsoever. We must imitate him, because the figure leaves his object entirely doubtful.

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*Observations.*—We are not sufficiently skilled in the art of navigating vessels to determine on the merit of Captain Cowan's patent, and therefore merely observe that he has obtained testimonials from several naval commanders in favour of the use of his method of reefing, as to expedition, safety, and strength, which are posted up at the Royal Exchange.

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*Mr.* T. J. Plucknett's *Patent for a Machine for mowing Grass and other Things. Dated August* 1805.—*Repert. Arts,* No. 52, *New Series.*

In Mr. Plucknett's machine a pair of common carriage wheels are *fixed* at the ends of an iron axle, so that by the going on of the wheels the axle is turned in collars: to this axle is fixed a cog-wheel, which communicates with two others, by which means it turns an upright shaft, to which a circular steel cutter, or knife, is fixed under the axle, higher or lower, according to its proposed use. The cutter traverses round the vertical shaft going through its centre, while the machine is conveyed along by two arms, in like manner as a common hand-cart. The knife, or cutter, is so adjusted as to make about 11 revolutions to 1 of the carriage-wheels: if the machine be driven by a man, the diameter of the cutter is about 20 inches; if by a horse the diameter is 3 feet. It is in either case a wrought or cast-steel plate, the whole of whose circumference is made perfectly sharp and fitted on a spindle, which fits a square hole through the knife pinion: the upper end of this pinion has a screw to adjust the knife to any height above the ground; and it revolves parallel to the surface of the earth: if it meets, while it is carried along by the carriage, with any obstruction, it will immediately (according to the specification) fly up through the hole above described, without stopping the machine, and adjust itself again as the obstacle is removed. To the carriage are fixed leaders carrying horns of iron or other metal, for the purposes of gathering the grass or corn, and presenting it so as to be readily cut by the knife.

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*Observations.*—Mr. Plucknett's specification is, in our opinion, rather obscure, and if we had not taken the trouble to examine the machine itself, we should have been at a loss to understand several of its parts: for instance, the patentee says that when the

knife meets with an obstacle, it will fly up so as to avoid it, and afterwards adjust itself as previously to the work; but the specification does not explain how this is to be effected, and the contrivance exhibited in the machine will not produce this effect when a large stone or other fixed obstacle presents an abrupt vertical projection; the knife must then cut through it or be broken, or the machine suddenly stopped. But if an obstacle present itself in the form of an inclined plane, the knife may fly up, as asserted. Besides, though the knife may be elevated a little, it cannot get above the cross-bar which holds the spindle steady; for that is immovable, and if not fixed low, will not answer the intended purpose.

We apprehend also that Mr. Plucknett's machine cannot be used without breaking down the corn or grass by the pressure of one of its wheels, and that if the gathering horns of the leaders are so adjusted as in some measure to prevent this, they will bring more corn or grass to the knife than can be cut, so as to leave a level surface parallel to that of the earth. We think too, since this machine cannot be of a very light structure, that in trundling it over the comparatively rough surface of a corn-field, so much force will be requisite, that a man would perform far more *effective* work with a good scythe; and if the machine is to be moved by a horse, we do not see any provision against his injuring the standing corn, when he draws the machine; and if he be placed behind to push it, as since recommended by the inventor, no means appear of preventing him from treading upon the corn cut down before him.

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# AGRICULTURE.

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*On the Culture of Wheat.—Farmer's Mag.* No. 25.

The Editors of the Farmer's Magazine some time ago offered a premium for the best essay sent to them for publication on the culture of wheat; and in No. 25, we find an essay under the signature D. to which this premium was adjudged. This writer commences with a remark, that though rents have in a few years past amazingly increased, yet the comfort and interest of the husbandman have not been thereby lessened; nay rather, that his property has been augmented almost in the like ratio with that

which has occurred in the improvement of the country. Wheat is now cultivated, says he, on a larger scale than formerly; the practice of modern times admitting this increased cultivation, without deteriorating the soil: he then considers the *soils* best adapted to the growth of wheat, and says, that rich clays and heavy loams are so naturally calculated for producing wheat, that it may be grown thereon almost every second year, if due care is taken to keep the land clean or in a husbandman-like condition; the intermediate crop to be manured, beans, in drills, a good summer fallow and dressing of manure to be given, every fourth, sixth, or eighth year, according to circumstances: any kind of clay or loamy soil may be made to bear wheat, by enriching it with a sufficiency of manure. For thin clays, a six course shift is recommended, viz. fallow and dung, wheat, grass, oats, pease or beans drilled, wheat, and then fallow again, as before. On light soils wheat cannot be so often or so profitably raised as on stiff land, and on real sands it ought not to be ventured, unless they are completely clayed or marled. The writer of this essay next considers the *culture* required for wheat, under which some observations on fallowing will be found, and others on manuring. The varieties of *seed* are next considered, under two principal divisions of red and white wheat: the latter he divides into thick chaffed and thin chaffed, and strongly recommends a variety of the latter, that has been selected and reared by Mr. William Hunter, of Knows, in East Lothian, as prolific, producing much good flour, and resisting inclement weather during its growth, perhaps owing to its strong roots. *Seed-work, pickling the seed, harvest management,* and *thrashing,* are considered in their order: and some of the observations therein we may advert to, when we come to notice other communications on these subjects; at present we have to add, that though many of the observations in this prize essay are very just, yet some of them are of a doubtful kind, and most of them have frequently been made before; and on the whole, the information obtained falls far short of our expectations, formed when we first saw this competition announced.

Another correspondent in this number of the Magazine, who signs *Arator,* relates his experience as to the best time of sowing wheat: on rich soils he prefers the first week in October, because earlier sowing is apt to produce plants too far advanced before the winter sets in: on hazardous soils it is, he says, good management to sow wheat after the first week of September, before the land is saturated with moisture; on thin clays, the second week in September is seldom too soon for sowing wheat.

*Description of a reaping Machine, to be wrought by one Horse, invented by Mr.* GLADSTONES, *Millwright, in Castle Douglass.* —*Farmer's Mag.* No. 27.

MR. Gladstones made a model of his reaping machine about two years since, which was mentioned to the Highland Society by Sir Alexander Gordon, and was at first patronized by them; their support, however, has been withdrawn, and the design of constructing one would have been entirely given up, had not Sir Edward Crofton happened to see the model, and ordered one to be made for him, which Mr. Gladstones was employed about at the time this communication was made.

To the extremities of an axletree, eight feet in length, are made fast two wheels, about as large as the fore-wheels of a waggon, which, with the axletree itself, turn in collars, in the same manner as the wheels of a Yarmouth cart, or that of a common wheelbarrow. Over the axletree is a frame of wood, seven feet wide, in which the collars are fixed, and to which the shafts and the machinery are fastened. The shafts are placed at the extremity of the near side, and occupy three feet in width; the machinery is four feet wide, and is placed on the off-side, so that it does not follow in the horse-path, but runs parallel to it; and so that when the horse walks by the side of the standing corn, the machine may cut down a four-feet breadth next the horse-path; and as the shafts are made to project ten feet forwarder than the machinery, the corn is to be thrown by the centrifugal motion of the knife, into the horse-path, after the horse has passed.

The machinery itself consists of a cog or tooth wheel, fixed to the axletree, and revolving with it, which turns the pinion of a breast-wheel, and this breast-wheel having its teeth laid at half a right angle, turns the knife-wheel, the teeth of which are laid at the corresponding half-right angle. In the centre of the knife-wheel, by a spindle which fits a square aperture, hangs the knife, which is circular. The knife is not made fast in the knife-wheel, but is kept in its place by its own weight, that when it meets with any pressure from below, it may be elevated in the hole, without raising the whole machine. The power is so contrived that one revolution of the wheels of the carriage shall cause about eleven revolutions of the knife. By means of a pulley, the knife is replaced after any jerk upwards, and a kind of rifle whetstone is so fixed as to be perpetually sharpening the knife. Immediately before the knife is placed a horn of iron, sharp at the edge, to open and raise, or cut through the corn; and a wheel with straight projecting teeth, several inches

deep, revolves on the same spindle as the knife, that the corn may be held between the teeth, which project forwarder than the knife, that it may be cut in two without slipping aside, and be retained till a three-pronged fork, which also revolves, gathers up the corn, and projects it into the horse-path. By means of a screw, the pinion may be set out of the cog-wheel, so that the knife may be at rest, while the carriage is taken to the field, or moved from one place to another.

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*Observations.*—The simple part of this machinery, as far as concerns the cog-wheel, the pinion, the breast-wheel, and the knife, is precisely the same as the machine for reaping and for mowing corn and grass, for which Mr. Plucknett, of Black Friars Road, has lately obtained a patent, noticed in a former part of the present Number. The pulley, the gathering wheel, and prong, to put aside the corn, are additions.

The great importance of lessening the expenses of labour in agriculture has called our particular attention to the reaping machine of Mr. Gladstones, and the patent machine of Mr. Plucknett. They are both constructed on the same principle. Admitting that these machines can execute their work without being impeded by obstacles, it must be apparent to every one that they cannot adapt themselves to the ground with the same closeness as a scythe. Mr. Plucknett has introduced into his machine a bar underneath, to keep steady the knife, and the gathering wheel in Mr. Gladstones' machine supplies the place of such a bar. With all these advantages, the knife cannot with safety be hung within three or four inches of the ground, and consequently cannot cut the corn so near as to allow of the possibility of making use of a rake to collect the scattered ears; and if the centripetal action of a scythe, an instrument of much larger diameter of motion than the knife of these machines, be unable to throw all the corn into the swarth without scattering some, much less will these machines be able; and therefore collecting the scattered corn with the rake cannot be dispensed with.

We consider this argument as conclusive against the introduction of these machines to supersede the use of the scythe in mowing corn and grass; and indeed Mr. Gladstones seems to be thus far of our opinion, for he calls his a reaping machine, and does not claim for it the merit of mowing, which Mr. Plucknett has specified in his patent. And if we confine their use to reaping only, we shall find them to be deficient in the most essential particular, namely, laying the corn so straight and neat, that it may all be tied in sheaves, without collecting afterwards by the hand or with the rake. For we conceive the chief reason for reaping wheat and mowing other grain is the superior value of wheat, which is liable to less waste, from being cut with the sickle and laid down by hand, than if mown with the scythe.

In severing corn which has been much laid (or laired, as the expression is in some counties), the stalks must necessarily be cut of very different lengths, and as the knife cannot be brought nearer than within three or four inches of the ground, much must be left uncut, for the horns cannot be expected to raise every ear. Doubtless much more corn may be severed in a given time by these machines, if not stopped by obstacles, which we have shewn to be far from impossible, than by the sickle or the scythe; but the mode in which the work will be done, will be more injurious to the farmer, than resorting to the usual methods.

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*Magnesia not hurtful to Vegetation. By* James Headrick. —*Farmer's Mag.* No. 27.

It appeared from experiments made some time ago by Mr. Smithson Tenant and another gentleman, that plants grew in the magnesian and the common limestone, when reduced to powder, equally well as they would have done in sand; but that when the magnesian lime was reduced to lime by burning, they would no longer vegetate in it. Hence arose the opinion that magnesia was hurtful to vegetation.

Mr. Headrick not being able to account for this on any principles of chemistry, held a contrary opinion. He had observed that different soils required a very different management in the application of lime; that some soils would be much benefited by small doses frequently repeated, but would be utterly destroyed by an excessive application; and that on other soils again it was scarcely possible to lay too much lime. And he concluded that the same might be the case with respect to magnesia. In some experiments within his own observation, lime had been injurious to vegetation, when applied in large quantities. He knew that magnesia and lime, and indeed any of the primitive earths, are of themselves the most sterile of all soils, and that the most fertile soil is formed from a variety of the primitive earths in certain proportions: yet, so far from magnesia being deleterious to plants, he was induced, from an experiment made in 1801, by Andrew Steele, Esq. to consider it an excellent nutriment. Mr. Steele sowed two pots, one containing one part of magnesia, and nine parts of earth, and the other containing one part of lime, and nine parts of earth. The plants in the pot containing magnesia throve better than those in the pot containing lime. And the same year he spread magnesia and lime in equal quantities over grassy turf, but could discern no difference in their effects. These results contradicting the experiments of Mr. Smithson Tenant, it was resolved by Mr. Headrick and some of his friends, to have recourse to a new set of experiments, which are described.

On 22d May 1806, six pots were sunk in a garden, and each had sown in it nearly an equal number of oats and peas.

No. 1, contained simple earth.
2, Magnesia, by measure $\frac{1}{12}$ mixed with earth.
3, Magnesia ..... $\frac{1}{6}$ mixed with earth.
4, Sulphate of magnesia $\frac{1}{10}$ mixed with earth.
5, Sulphate of magnesia $\frac{1}{20}$ mixed with earth.
6, Muriate of magnesia $\frac{1}{20}$ mixed with earth.

On the 30th June he recorded his observations. The peas were most thriving in Nos. 2 and 3, but particularly so in No. 3, where they were more than a foot high. This convinced him that magnesia was analogous to lime in powerfully promoting the growth of leguminous crops. The oats were taller in No. 3 than in No. 2, and in No. 2 more vigorous, and of a deeper green than in No. 1; from which he concluded, that magnesia powerfully promoted the growth of oats as well as peas; and that the greater the quantity applied, the more striking the effect in both. Nos. 4, 5, and 6, remained long dormant, but at length began to shoot, which convinced him that sulphate and muriate of magnesia are not in themselves hurtful to vegetation; but if applied in large quantities, considerably retard its progress. He thinks the facts adduced clearly establish this position, that magnesia, and most, if not all its saline combinations, so far from being hurtful, are beneficial to vegetation, if used in due proportion.

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*Observations.*—Mr. Headrick deserves the acknowledgments of the agricultural world for these experiments. Though magnesia is not likely to become a manure of common application, it is important to those who may have an opportunity of applying it, that its effects should be ascertained by experiment, and not rest solely on theory. Where theory and experiment coincide, as they do in this case, farther trials are unnecessary, and the farmer's way is plain before him.

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*Remarks on the Rev. Mr.* Campbell's *Essay on the Cultivation of Potatoes. By* Rr.—*Farmer's Mag.* No. 27.

The writer admits that he had read Mr. Campbell's Essay with great pleasure, for he considered it important to know the best mode of cultivation of that useful vegetable. He limits his remarks to that part of the essay which considers the propriety of the comparative application of dung in different circumstances, and divides them into two branches. In the first; he considers his experiments as referring to *poor* soil, at a distance from dung

and markets, and in the second as referring to rich soil in the vicinity of both.

He holds it to be perfectly obvious from the experiments under consideration, that the cultivation of potatoes can never be extensively followed, where no foreign dung is to be had but from a great distance, and the market is equally distant with the dung, and observes that either of these two circumstances will occasion the expense of the crop to exceed the marketable value of the produce; and he shews from Mr. Campbell's experiments, that on poor land, though no value is put on the dung, the loss is, in the most favourable result, more than 11*s.* per statute acre. In regard to such articles as are of indispensable necessity to a farmer's family, and which cannot be procured but by his own culture; he thinks it quite vague to argue about profit or loss, but recommends a greater breadth to be sown on better land without dung, that the dung may not be taken away from productive, for the sake of raising potatoes on a poor soil, which will at best give but an uncertain return of produce.

With respect to the cultivation of potatoes on rich soil in the vicinity of dung and markets, he considers the case may be different; but on examination of Mr. Campbell's experiments, cannot find in any case a profit of more than 2*l.* 12*s.* per statute acre. From these results he is of opinion that potatoes for the market, even on rich soils are not the most beneficial produce to the farmer, and that his manure and labour may be applied to purposes more advantageous both to himself and the country at large. He thinks that every farmer upon turnip soil, and accustomed to the advantages of legitimate turnip husbandry, will grudge like a miser, every cart-load of dung diverted to the production of potatoes; and he denies his concurrence to Mr. Campbell's conclusion,—"that the occupier of poor land, where the value of the produce is small, should, though limited in his means of providing manure, apply that article very liberally to his potatoe crop;" and maintains that the occupier of rich land may raise any other crop than potatoes with more profit to himself. He considers the number of seedling plants, which always grow the year following a potatoe crop, to be a great objection to the general introduction of potatoes into the field, in rotation with crops of corn.

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*Observations.*—The writer of the remarks is completely at variance with the reverend author of the essay; and in our opinion the best of the argument as to the most profitable husbandry, is with the writer of the remarks. Mr. Campbell's philanthropy induced him to undertake the experiments he has recorded, and the profitable result has caused him to recommend the general culture of that valuable root, the potatoe; but with him comparative profit seems not to have been considered: he did not calculate whether

an equal expense of cultivation would produce more profit from a crop of wheat, or beans, or potatoes, or turnips, but whether potatoes might or might not be cultivated with a profit; and by what means with the greatest profit. His essay is complete and satisfactory in itself as to the culture of potatoes; but as the relative profit of potatoes with any other crop is no part of the question he discussed, the remarks of Rr. however accurate and valuable they may be, do not apply to Mr. Campbell in the extent he wishes to convey to his readers.—For an account of Mr. Campbell's paper see our last Number.

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*On the good Qualities of the "Ryland Breed of Sheep." By* James Powell, *Esq.—Young's Annals,* No. 260.

Mr. Powell endeavours to impress on the Bath Society, to whom his letter is addressed, the excellence of the *pure* Ryeland sheep, not in fineness of wool only, but in hardiness under severe treatment, and in tendency to food. He is of opinion that they are the same species as the Spanish sheep, and that the difference which now exists between them has been caused by the variation of climate, and from greater attention having been paid to preserve the purity of the Spanish flocks from corruption by crossing with other breeds.

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*Account of the Success attending the Introduction of Spanish Sheep into the Department of L'Oise in France. By the Duke of* Liancourt.—*Young's Annals,* No. 260.

The accounts which the Duke of Liancourt has received from France on the subject of a part of his Spanish flock, which escaped the wreck of the Revolution, lead to similar conclusions as in the foregoing paper, and established the superior hardiness of the Spanish breed to the common flocks of France. It is deserving of recollection, that though the ewes of both the Spanish and Ryeland sheep are without horns, yet the rams have very large ones; and that all the individuals of both breeds are marked with an iris round the eye, and a frill down the bosom; where these characteristics are wanting, the breed is not pure.

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*Observations.*—We have been rather concise in our account of the two preceding papers, because they are neither new nor very important; and for similar reasons we omit to notice particularly the other articles in the same number of the Annals. They are an account of the produce of a cow, the property of William Cramp of Lewes; and a paper by Mr. Edward Powys on feeding cattle with green food, which give sanction to the beneficial effects

to agriculture, that arise from the soiling system, even in the summer months, by preventing waste of food, and by obtaining an increased quantity of manure. Also a letter from Mr. Jefferson, the President of the United States, to Sir James Sinclair, so long back as the year 1798, in which there is a description of the mould-board of a plough of his contrivance.

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*On the defective Management of Fruit-trees, with the Opinion and Practice of her Serene Highness the Margravine of Anspach. —Agr. Mag.* No. 2, *New Series.*

This lady having observed in her travels the very great superiority of the crops of fruit in the gardens of France over those of England, adopted the method of pruning used by the tailleurs des arbres of France, in preference to the system recommended by T. S. D. Bucknall, Esq. and Mr. Forsyth. The communication was made to the Agricultural Magazine by Dr. Taylor, the Secretary to the Society of Arts, who says, as he had been informed by the Margravine, that in France the management of fruit-trees was a business regular and distinct from that of the common gardener, and that it was usual to have one person in each village or district, known by the appellation of "tailleur des arbres," who was wholly employed in superintending the fruit-trees of the district; that it was found to be injurious to have lofty standard fruit-trees, and wide-expanding branches, as in the first instance the sap was exhausted in wood and leaves instead of fruit, and the extending branches were liable to be damaged by the wind, and then become cankered; that even in espaliers and against walls it was found improper to have very long branches, as in such the sap is liable to be checked in circulation by changes of the weather, and the trees become blighted; and that to ensure good crops, and to produce fine fruit, the trees should be kept low, and the branches commence as near the ground as possible, and be cut shorter, and suffered to grow closer together, than they usually are in England. It is asserted that by these means the sap will circulate more freely and be less acted upon by the weather, and the fruit be better screened in inclement seasons.

The fruit-trees in her Highness's garden at Brandenburg House, at General Conway's near Henley, and at Lady Rivers's at Wandsworth Hill, are stated to have been cultivated in this manner, and that the success warrants the introduction and recommendation of the system.

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*Observations.*—The great attention and expense which is bestowed on horticulture in England render every thing acceptable to the public, which tends to promote this fashionable and useful

science. The mode of pruning recommended in this communication is worthy of attention, and we think gardeners will experience its effects more particularly in the apricot, and the choicer kinds of pears.

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*Cure for the Smut in Wheat. By a Somersetshire Farmer.—Agr. Mag.* No. 2, *New Series.*

This writer having found the usual methods of preventing the smut in wheat to be frequently ineffectual, adopted the following process. He heated a half hogshead copper till the water in it boiled; then added about one peck of lime, and stirred it till it was all slacked and incorporated with the water. He then began the operation by taking a fine wove bushel basket, about three parts full of wheat, and dipping it into the copper, taking care to keep it boiling; and to every three or four baskets of wheat he added a few knobs of lime. As soon as the wheat was wetted, and had been stirred round two or three times, he emptied it on a plain floor to dry. The anonymous author of this communication asserts, that ten years experience has evinced the success of his plan, and that he has never himself found, or learned from others, that the vegetation of the corn has been destroyed by the process in a single instance.

*Observations.*—Lime has never been found effectual in preventing the smut, when made into brine, or mixed with the corn; and as we do not know that its quality is altered by a mixture with boiling water, we think the effect may be produced by the boiling water only, and recommend some diligent and attentive farmer to try the experiment in boiling water without lime, and notice the result for the benefit of his countrymen.

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*On Ploughs. By an old Farmer.—Agr. Mag.* No. 2, *New Series.*

An Hertfordshire correspondent, who sends this communication, remarks that all double-furrowed ploughs are calculated for lands not too wet and heavy, and free from obstructions; and of the different ploughs of this description he gives the preference to those which have been improved by Lord Somerville. By the use of these ploughs, he thinks the work of one man may be saved, and frequently on light soils the work of one ox or horse. These ploughs may be driven with reins, as well as single-furrow ploughs, if the cattle be put double. On inquiring from the labourers on a farm in Berkshire, where both horses and oxen were employed in ploughing, to which a preference was due, he

did not find that there was any material difference. He is of opinion that on the light lands of Norfolk and Suffolk the two-furrow plough drawn by three Devon or Glamorganshire oxen, would easily complete three acres in a day, or perhaps more. He does not consider the old two-furrow plough, which kept its hold in a free soil without assistance, and which is now rarely met with, so capable of performing an equal quantity of work as Lord Somerville's plough. The latter he believes to be now generally made, and by the common mechanics in Leicestershire and the adjoining counties.

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*Observations.*—These remarks are no other way interesting, than as the recommendation of the double-furrow plough for light soils is repeated by a person whom we presume to be a farmer of experience.

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*On the Navel-ill in Calves. By* Frank Sitwell, *of Barmon Castle, Northumberland.—Farmer's Mag.* No. 27.

This disorder, for which no remedy had been previously discovered, is an inflammation of the navel-string, which takes place between the third and the tenth day. It is very common in the north of England, and is there considered so fatal, that butchers and graziers refuse to purchase calves till they are too old to be afflicted with the disorder. Mr. Sitwell had a calf of three days old, which left off sucking, and breathed with difficulty; there was a considerable discharge of saliva from the mouth and nose, and a great inflammation and hardness about the navel. He gave it "one glass of port wine, one table spoonful of powdered bark, and one hundred and fifty drops of laudanum;" and ordered the belly to be well fomented every two hours with a hot infusion of camomile flowers and marshmallows: the next morning he administered two tea-spoonfuls of rhubarb in a little milk, and renewed the fomentation.

The calf took to sucking again on the second day of the medicine; but as the difficulty of breathing still continued on the third morning, he repeated the dose of port wine, laudanum, and bark, but discontinued the fomentation, because the inflammation had subsided. From this time recovery was no longer doubtful, and the calf went on thriving as well as those which had not been afflicted with the disorder.

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*Observations.*—Though certain disorders among cattle may prevail more in one district than another, yet a certain cure cannot be too generally known. We have for this reason not rejected this article on account of its local tendency. We agree in opinion

with the editor of the Farmer's Magazine, that "were gentlemen of experience and observation generally disposed to favour the public with the result of experiments made by them in the different branches of rural art, it is impossible to calculate the advantages which necessarily would follow."

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*On Cheviot Sheep.—Farmer's Mag.* No. 27.

The gentlemen who form the Cheviot Society having, in 1803, resolved to enter upon some experiments, in order to prove whether Cheviot sheep would feed at an early age, in July that year a committee selected a few lambs from the flocks of some of the members for those experiments. Some of these were killed in November 1804, and averaged from 20 to 21½lb. per quarter, with from 13 to 14lb. of tallow each; others were killed in July, September, and October, 1805, averaging 28lb. per quarter, and had about 18lb. of tallow each. From this result the breeder, who made the communication, considers the fact, "that Cheviot sheep will feed at an early age," to be sufficiently established; and adds, that repeated experiments have convinced him of the superiority of the Cheviot over the forest breed of sheep, and all other kinds in highland situations.

*Observations.*—The Cheviot sheep are naturally active, and brave the sleety blasts, which are common in mountainous situations, without shrinking from them in the severest seasons. They are peculiarly calculated for enduring storms and cold without injury, and are therefore a very desirable breed for the Highlands of Scotland. In hardiness they will stand a comparison with the Ryeland and the Spanish, and are thought by many farmers to be preferable to either for the exposed climates of the North.

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*Rotation of four Crops—Potatoes, Barley, Clover, Wheat.—Agr. Mag.* No. 83.

The profit on eighty acres, cultivated in equal portions in this rotation, is stated by a Man of Kent to be 622*l.* per annum. He states, that as soon as his wheat crop was got in, he dunged his land after the rate of 30 loads to the acre; planted the potatoes in April or May, 6 sacks to the acre, hand-hoed them soon after they were up, and earthed them up with a double mould-board plough in August, and took them out of the ground in October. He then cleaned the ground well by harrowing previous to sowing the barley in the succeeding spring: he drilled the barley three bushels to the acre, and sowed the clover with a top-dressing of

coal-ashes. The wheat was also drilled with the same quantity to the acre as the barley, and kept very clean during the summer by hand-hoeing and hand-weeding. The result was,

| | Expense per Acre. £. | s. | d. | Produce per Acre. £. | s. | d. | Profit per Acre. £. | s. | d. | Total Profit. £. | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Potatoes | 15 | 18 | 6 | 24 | 0 | 0 | 8 | 1 | 6 | 161 | 10 | 0 |
| Barley | 5 | 5 | 0 | 13 | 0 | 0 | 7 | 5 | 0 | 155 | 0 | 0 |
| Clover | 5 | 1 | 0 | 12 | 0 | 0 | 6 | 19 | 0 | 139 | 0 | 0 |
| Wheat | 6 | 7 | 6 | 14 | 14 | 0 | 8 | 6 | 6 | 166 | 10 | 0 |
| | | | | | | | | | | £ 622 | 0 | 0 |

*Observations.*—On light soils, where drills are regularly used, this method of cropping may be found very beneficial; we did not, however, expect to see beans totally excluded from any rotation of crops where fallowing was omitted. The roots of the bean tend more than those of any other corn to render the ground hollow, and a drilled crop of them kept very clean would, in our opinion, be found more advantageous to the land, and more profitable, than barley after the potatoes.

*Feeding of Sheep off Wheat.—Agr. Mag.* No. 1, *New Series.*

Two communications are made to the editor on this subject, both decisively against the practice. The most common pretence offered in support of it, is preventing the wire-worm from eating the root of the plant, by rendering the texture of the soil more impenetrable to this destructive insect. Some farmers too assert, that the number of stalks are increased by the sheep cropping off the head of the leading shoot. Both these opinions are rationally controverted.

S. K. R. *is informed, in reply to his inquiry, that the* amadou, *or prepared agaric, used instead of tinder on the continent, is principally prepared from the* boletus igniarius *of Linnæus, merely by beating it to render it softer. Tragus, in his Historia Stirpium (as quoted by Ray, in his Synopsis, and also in his Historia Plantarum), says, the fungus is boiled in ley, and sometimes in a solution of nitre, to render it more susceptible of catching fire. Other fungi of a coriaceous texture are also used for the same purpose.*

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# RETROSPECT

OF

# PHILOSOPHICAL, MECHANICAL, CHEMICAL AND AGRICULTURAL DISCOVERIES.

No. VII.] *October, November, December.* [1806.

## NATURAL PHILOSOPHY, ARTS, AND MANUFACTURES.

*Summary of* COULOMB's *Experiments on Friction. By* M. LIBES. —*Nouveau Dictionnaire de Physique, Tom.* ii. & iii.

WE are indebted to Coulomb for an extensive series of ingenious experiments relative to friction. They are described in a memoir published in the sixth volume *Des Savans Etrangers*, and we shall here present the most valuable results.

1. The friction of wood sliding over wood (both being dry) opposes, after a sufficient time of quiescence, a resistance proportional to the pressure: that resistance sensibly augmenting in the first instants of repose; but after some minutes it ordinarily attains its *maximum*.

2. When wood glides dry over wood with any velocity whatever, the friction is still proportional to the pressure; but its intensity is much less than that which is experienced in detaching the surfaces after some instants of rest: it is found that the force necessary to detach and cause to slide two surfaces of oak, after some minutes of quiescence, is to that required to overcome the friction, when the surfaces have already acquired any degree of velocity whatever, nearly as 9 to 2.

3. The friction of metals sliding over metals without oiling or greasing, is equally proportional to the pressures; but its intensity is the same, whether the surfaces are detached after some time of repose, or whether they preserve any uniform velocity whatever.

4. Heterogeneous surfaces, such as woods and metals, sliding the one over the other, without oiling, give for their friction very different results from those which precede: for the intensity of their friction relatively to the time of repose increases slowly, and

does not arrive at its limit till after four or five days, and sometimes more, while in metals the limit is attained in an instant, and in wood, after some minutes. This extinction is even so slow that the resistance of the friction in insensible velocities is almost the same as that which must be surmounted in moving or detaching the surfaces after some days of quiescence. Nor is this all: in wood sliding ungreased over wood, and in metals gliding over metals, the velocity has only a very little influence upon the friction; but here the friction augments very perceptibly in proportion as the velocity is augmented; so that the friction increases nearly according to an arithmetical progression, when the augmentation of the velocity is conformable to a geometrical progression.

The resistance generated by friction is diminished by plastering over the surfaces with some greasy or fluid matter. Thus, we rub with soap the edges of a box whose cover sticks too close: we oil joints or hinges to facilitate their motion: we grease the fellies of wheels within. These being so many means by which we fill up the grosser inequalities of the surfaces, and render them more fit to slide over one another. Besides, the moleculæ of these interposed fluids change the species of friction; their spherical form causing them to roll with facility between the surfaces, which serve them as a common vehicle, and thus transform the friction of sliding bodies into that of rolling bodies, which is always the most minute.

The Memoir of the same philosopher on the friction of pivots, is inserted among the Memoirs of the Paris Academy for the year 1790. Though it has been so long published, it is scarcely known even in France: yet as the experiments described are very interesting, and furnish some important results, M. Libes thought it right to give a rather copious account of them.

Bodies which are made to turn upon pivots are usually suspended by means of a cheek, socket, or collar, of very hard matter. The collar has its cavity of a conic form, and terminated at its summit by a little concave segment, whose radius of curvature is very small. The point of the pivot which is sustained by this collar forms at its summit a little convex surface, whose radius of curvature should be still smaller than that of the extremity of the cheek. Experience evinces that the curvature of the bottom of the socket is irregular, and that the friction of a collar of agate on which a pivot turns, is frequently five or six times more considerable than the *momentum of friction* of a well-polished plane of agate on which the same pivot turns.

These considerations induced M. Coulomb to employ in the course of his experiments, not a cheek or a socket, but a well-polished plane, to support the body on the point of a pivot. To prevent the body from sliding he took care that its centre of gravity should be very low, with respect to the point of suspension:

he then made the body to whirl or spin about its pivot, by impressing upon it a rotatory motion. By means of a seconds watch, he observed exactly the time employed by the body in making the first four or five turns, and he thence deduced easily a mean turn to determine the primitive velocity: after this he counted the number of turns which the body made before it stopped.

Coulomb took a glass bell of 48 lines in diameter and 60 lines in height, which weighed 5 ounces. He placed it on the point of a pivot; and after giving it successive degrees of velocity about that pivot, he observed very exactly the time that it employed to make the first turn, which gave him for the mean velocity that which answered to the half of such first turn. He then estimated the number of turns made by the bell before it stopped: the results were as below—

1*st Trial.* The bell made one turn in 4″, and came to rest after $34\frac{1}{10}$ turns.

2*d Trial.* The bell made one turn in $6\frac{1}{4}''$, and stopped after $14\frac{1}{10}$ turns.

3*d Trial.* The bell made one turn in 11″, and stopped after $4\frac{6}{10}$ turns.

Now if $b$ denote the primitive velocity, X the space described between the commencement and the end of the motion, A the constant momentum of the retarding force; $\int\frac{\mu r^2}{a}$ the sum of the products of every particle $\mu$, by the square of its distance $r$ from the axis of rotation, divided by the quantity $a$ measuring the distance from the axis of rotation to the point whose primitive velocity is $b$, it is easy to find the following analytical expression for the constant momentum of the *vis retardatrix*, viz.

$$A = \frac{b^2}{2X}\int\frac{\mu r^2}{a} .$$

But, because in the three preceding trials, the same bell was employed, the quantity $\int\frac{\mu r^2}{a}$ is the same: $\frac{b^2}{X}$ must therefore be a constant quantity if A be constant, and reciprocally. But in each trial there was reckoned the time employed by the apparatus in performing an entire revolution. The mean velocity, or the velocity due to the half of each first revolution, will, therefore, be measured by the circumference run over. The space described up to the end of the motion, will be measured by the number of turns run through from the instant where the mean velocity was determined until the end of the motion. Thus by computing from the data furnished by the three trials, we may form the following table:

| | | | |
|---|---|---|---|
| 1*st Trial.* | 1 turn in 4″, | stops at $34\frac{1}{10}$ turns, | whence results $\frac{b^2}{X} = \frac{1}{1147}$ |
| 2*d Trial.* | $6\frac{1}{4}''$ | $14\frac{1}{10}$ | $= \frac{1}{550}$ |
| 3*d Trial.* | 11″ | $4\frac{6}{10}$ | $= \frac{1}{553}$ |

This experiment, then, shews unequivocally that the quantity $\frac{b^2}{X}$, and consequently the quantity A which expresses the momentum of friction, are constant quantities, whatever be the primitive degree of velocity; and that, consequently, the velocity has not any influence upon the *resistance* due to the friction of pivots, which from this experiment is necessarily proportional to a function of the pressure.

When this experiment is made in a vacuum, a much less heavy body may be employed, and of any form whatever, and the same result will be obtained.

In other experiments Coulomb bent a brass wire of 9 inches in length; the parallel branches were 24 lines distant from one another; the part of the wire curved in the form of a semicircle which joined the two branches was about 3 inches long; and the two vertical and parallel branches were also each 3 inches long. To the extremity of each vertical branch was attached by means of wax a piece of metal, and there was fixed, in like manner, in the middle of the concave part of the wire, to serve for the cheek or bush, a small well-polished plane of different substances on which the friction of the point of the pivot was to be determined: finally, there was fixed to the summit of a support a little needle of tempered steel, and whose point it was necessary to render more or less fine, rounded, or obtuse, according to the nature of the cheeks, and to the pressure which they were to experience. The extremity of the needle first used by Coulomb, appeared, when examined by a microscope, to form a conic angle of 18 or 20 degrees. The friction of this needle against well-polished planes of granite, agate, rock crystal, glass, and tempered steel respectively, was tried; and the result, taking in each experiment the mean quantity represented by $\frac{b^2}{X}$ (a quantity which was always found to vary between very narrow limits), gave the momentum of friction of the point of the needle against the planes of granite, agate, &c. respectively, in the ratio of the fractions $\frac{1}{1029}$, $\frac{1}{847}$, $\frac{1}{784}$, $\frac{1}{579}$, $\frac{1}{487}$: so that the momentum of friction of the plane of granite being represented by unity, we shall have for the momentum of the fricton of rotation relative to the other substances as below: friction of granite, 1; of agate, 1.214; of rock crystal, 1.313; of glass, 1.777; of steel, 2.257.

Coulomb likewise employed himself during these experiments, in determining the more or less acute form which should be given to the points of the pivots. To this end he caused to be successively rounded into cones of greater or less acuteness, the extremity of a steel needle, that it might thence appear whether the change of figure had any influence upon the friction. Thus he found that, under a certain charge, the point of the pivot being

shaped to 45 degrees, the quantity $\frac{b^2}{X}$ was, for granite, $\frac{1}{2500}$; agate, $\frac{1}{2100}$; glass, $\frac{1}{1400}$; tempered steel, $\frac{1}{2000}$.

Coulomb then gave to the point a more acute form, so that the angle of the cone which terminated it, could not be more than 6 or 7 degrees; and he found, still retaining the same charge or pressure as before, that the quantity $\frac{b^2}{X}$ was, for agate, $\frac{1}{800}$; glass, $\frac{1}{450}$; tempered steel, $\frac{1}{250}$.

Comparing from these, and other experiments, the momentum of friction of rotation of the point of different pivots against a plane of agate, he found that the quantity $\frac{b^2}{X}$ which varies as that momentum, was, for a pivot of 45°, $\frac{1}{2100}$; a pivot of 15°, $\frac{1}{1200}$; a pivot of 6°, $\frac{1}{800}$.

After this Coulomb varied the charge in his experiments, and determined the relative momentum of friction of pivots under different pressures. But without going further into detail, we may give the following as the principal deductions from the whole.

1. That the friction of pivots is independent of the velocities, being merely as a function of the pressure.

2. That the friction of granite is less than that of glass.

3. That the figure of the point of the pivot as to acuteness, affects the quantity of friction; in such manner that when we cause to whirl upon the point of a needle, a body weighing more than 5 or 6 drams, the most advantageous angle for that point appeared to be from 30° to 45°; under a less pressure, the angle might be progressively diminished, without the friction being perceptibly augmented: it may even without great inconvenience be reduced to 10° or 12° with good steel, when the charge does not exceed 100 grains: an important consideration in the suspension of light bodies upon cheeks or sockets.

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*Observations.*—Although a pretty full account of several of Coulomb's experiements relative to friction has been given in the second volume of Gregory's Mechanics, and a judicious summary of his principal results in the second volume of Brewster's edition of Ferguson's Lectures; yet do these authors, and indeed every other English author (as far as we recollect), appear unacquainted with those experiments relative to the friction of small pivots, the results of which are here given by M. Libes. We conceive that the knowledge of these and similar experiments may be turned to good account by the ingenious artists of this country, especially the makers of chronometers; and we have therefore thought it our duty to lay them before the English reader: hoping that some of our philosophers will extend and diversify researches that are likely to be so beneficial.

For the sake of such of our readers as may wish to be convinced

of the truth of M. Coulomb's theorem for the momentum of friction, we shall here add a method of investigating it, which may be readily comprehended by every mathematician. Conceive in the body which turns upon a pivot a section perpendicular to the axis of rotation, and represent by $a$ the distance of a given point from the axis of rotation, and its velocity by $u$; denote also by $r$ the distance of any molecule $\mu$ from the axis of rotation; then the velocity of that molecule $\mu$ about the axis of rotation will be $\frac{\mu r}{a}$, and the instantaneous variation of the momentum of that particle about the axis of rotation will be $\frac{\mu r^2 \dot{u}}{a}$; and as the momentum of the force, supposed constant, which retards the motion, is equal to the sum of the increments of the momenta of all the moleculæ, we shall have the equation

$$A\,\dot{t} = -\dot{u}\int\frac{\mu r^2}{a}.$$

Introducing into this formula $\dot{x}$ for the space described in the indefinitely small time $\dot{t}$ by a point whose velocity is $u$, or multiplying the members of this formula, by the corresponding members in the known theorem $\frac{\dot{x}}{\dot{t}} = u$ for forces whether constant or variable, there will arise

$$A\,\dot{x} = -u\,\dot{u}\int\frac{\mu r^2}{a}.$$

And if A, or the momentum of the *vis retardatrix*, be a constant quantity; if, moreover, at the commencement of the motion the velocity $u$ is equal to $b$, the fluent of the preceding expression will be

$$2\,A\,x = (b^2 - u^2)\int\frac{\mu r^2}{a}.$$

Whence it follows, that if the momentum A of friction be a constant quantity, $b$ the primitive velocity, X the space described by the point whose velocity is $b$, from the instant when that velocity was observed, till the termination of the motion, we shall have, at the end of the motion,

$$A = \frac{b^2}{2X}\int\frac{\mu r^2}{a};$$

which is the expression for the momentum of friction exhibited by Coulomb.

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*On the Measurement of Heights by the Barometer, according to the Theory of* Laplace. *By* M. Daubuisson.—*Journal des Mines*, No. 113.

This paper, which occupies more than 30 pages, treats of the principal rules which have been proposed for the determination of

altitudes by the barometer and thermometer; and more particularly of the method proposed for this purpose by M. Laplace, in his *Mécanique Céleste*. In this method the constant co-efficient by which we must multiply the number given by the logarithmic tables (that is the difference of log. H and log h), depends upon the ratio between the weight of a determinate volume of mercury and that of an equal volume of air, at the temperature of thawing ice, at the mean height of the barometer at the surface of the sea. The hypothesis of an uniform temperature at the zero of the centigrade thermometer, requires two corrections. If the temperature be any other than that assumed, the half sum of the temperatures observed at the two stations, must be taken for the mean temperature of the column of air. This done, the air is dilated by $\frac{1}{250}$ of its volume for every superior degree of the centigrade scale; therefore the quantity by which it is necessary to augment the constant co-efficient on this account, is equal to the product of that co-efficient by $\frac{1}{250}$, and by the number of degrees which indicate the mean temperature. The other correction depending upon the thermometric effect of the heat upon the barometer column, is the same as in the well-known rules of Deluc; proceeding solely from this basis that the mercury is dilated by the $\frac{1}{3412}$ of its volume for every degree of the centigrade thermometer. But, besides these general corrections, Laplace makes others for the different degrees of humidity of the air, and the variation of gravity at different latitudes. The resulting theorem which M. Daubuisson lays down, as "the last word of the calculus," is as follows:

$$x = 18336^{m}\left(1 + 0.002(t+t')\right)\left(1 + 0.002845 \cos. 2L\right)\left[\left(1 + \frac{x'}{a}\log.\frac{H}{p\left(1 + \frac{T-T'}{5412}\right)}\right) + \frac{x'}{a}\,0.868589\right]:$$

where x = the required altitude in metres to be ascertained by the instruments, H and h the elevations of the mercury in the barometer at the lower and upper stations respectively, t and t' the numbers of degrees marked upon the centigrade thermometer at those two stations, T and T' the temperatures of the barometer at the same stations, expressed in like measures, L the latitude of the place, a the earth's mean radius expressed in metres, viz. 6366198, the logarithms the common tabular ones, and x', the approximate value of the height, ascertained by the formula

$$x' = 18393^{m}\left\{1 + 0.002\,(t + t')\right\}\left\{\log.H - \log.h\left(1 + \frac{T-T'}{5412}\right)\right\}$$

M. Daubuisson has likewise given an approximate rule independent of logarithms, for the height, assuming the mean temperature at the level of the sea, and the mean altitude of the barometer; it is this: *Take the difference between the observed baro-*

*metric elevation expressed in centimetres, and* $76\frac{1}{3}$, *add the* $\frac{2}{3}$ *of this difference to* 110 *metres, and multiply the sum by the said difference, so shall we have within a few metres, the height of the place above the level of the sea.* Above 2000 metres, the $\frac{3}{4}$ of the difference must be added instead of $\frac{2}{3}$, and this alteration will answer until the altitude exceeds 3500 metres.

This paper is accompanied by a plate, exhibiting the comparative motion of the barometer at Paris, Rouen, Besançon, Geneva, Grenoble, Tolouse, and Marseilles, in January 1806.

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*Observations.*—The memoir, of which we have just given a concise abstract, exhibits tokens of that prejudice against English philosophers, which we are sorry to say is by far too commonly manifested in the writings of the French philosophers of the present day. Thus, although we have a history of the various investigations of rules for the barometrical admeasurement of altitudes, it takes no notice whatever of the elegant researches of Dr. Halley, published in No. 181 of the *Philosophical Transactions*, in which he deduced rules by means of the relation subsisting between the density of the air at different altitudes, and the ordinates of that kind of logarithmic curve known by the name of *atmospherical logarithmic*. Nor is there any mention of the elaborate paper by Mr. Professor Playfair, published in vol. ii. of the *Edinburgh Philosophical Transactions*; though that gentleman has taken notice of other sources of error than those considered by Laplace, and particularly of the diminution of the *weight of the mercury* in the upper barometer.

As to the principle assumed by M. Laplace, from which he infers the value of the constant co-efficient, it is essentially the same as that assumed by Dr. Hutton, when conducting a similar investigation. The Doctor's method was published ten years ago, under the word ATMOSPHERE, in his *Mathematical Dictionary*, and the same rule and investigation have since been published by various other authors as *his*: so that it is not a little strange that Daubuisson, Haüy, Biot, and Libes, not to mention other French authors, continue to repeat their ascription of the principle to Laplace, when they ought to have known, and *would* have known, had it not been for the prejudice we are now complaining of, that it is due to an Englishman. With regard to the abstruse rule, comprehended in the resulting formula, or, as Mr. Daubuisson terms it, "the last word of the calculus," we should not recommend its adoption in this country, even if it were so transformed as to correspond to our established measures: for the rules given by Deluc, Shuckburgh, Hutton, Robison, Englefield, &c. are all far simpler, and are productive of as accurate results as can reasonably be expected, unless we had some method of determining the altitudes of the mercury in the instruments with more precision than is now, or ever likely to be known.

*Description of an Odometer for a Carriage, and some Remarks on the Patent Boring Machine of Mr.* RYAN. *By* R. L. EDGWORTH, *Esq.—Phil. Jour.* No. 61.

MR. Edgworth's odometer may be easily attached to the axletree bed of a post-chaise, gig, or any other carriage. One turn and a half of a screw is formed round the nave of one of the hinder wheels by a slip of iron, which is wound round the nave, and fastened to it by screws passing through five or six cocks, that are turned up at right angles on the slip of iron. The helix so formed on the nave of the carriage-wheel acts as a worm or screw upon the teeth of a wheel called A, which should have 20 teeth, if the carriage-wheel be 5 feet 3 inches in circumference. On the arbor of the wheel A there is a brass endless screw called B, which acts upon a brass wheel C of 80 teeth; this latter wheel serving as a dial-plate, and is divided into miles, halves, quarters, and furlongs. The figures indicating the miles are nearly $\frac{3}{4}$ of an inch long, so as to be quite distinct: they are pointed to by an index which projects from a fixed point a little way over the plate, in such a manner as to be easily seen from the carriage, as well as the figures passing successively beneath it. The two brass wheels A and C are mounted by irons with pivots upon a rectangular block of wood, which is to be screwed upon the axletree bed, and, if the carriage permits, in such a manner that the dial-plate may front the eye of the person who looks from the carriage.

There is a ratchet-wheel attached to the arbor of the wheel A, which by means of a click allows the wheel to be set with a key or handle fitted to the square end of the arbor. There are two springs, one adapted to the wheel A, and the other to the dial-plate wheel C, to prevent them from shaking by the motion of the carriage.

Such an apparatus will estimate distances for 5 miles, and an additional wheel of 81 teeth would render it fit to count 400 miles. If the carriage-wheel be either larger or smaller than 5 feet 3 inches in perimeter, it will still be easy to adapt an odometer to it.

The remainder of Mr. Edgworth's communication relates to Mr. Ryan's patent boring machine for exploring the strata of mineral countries. This machine acts like the surgeon's *trepan*; and cuts a circular hole, leaving a *core* in the middle, which is drawn up from time to time by a pair of self-closing tongs. In the trial of this instrument witnessed by Mr. Edgworth, the core was as true and smooth as if turned in a lathe, and the under surface shewed exactly the fracture by which it was detached

from the block at bottom. Thus the pieces brought up by this contrivance afford a very accurate knowledge of the strata, while mines may be ventilated by it at small expense.

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*Observations.*—Mr. Edgworth's odometer has simplicity and ingenuity to recommend it, as indeed have most of the contrivances of this public-spirited gentleman. But his account of it is deficient in perspicuity: at least, it is by no means obvious, that wheels and endless screws of such dimensions as he mentions (independent of some particulars not included in the description), will enable the dial-plate to furnish an estimate measure to the distance of 5 miles.

As to Mr. Ryan's boring apparatus, we wish it more success than it has hitherto met with; for it would be found extremely useful in ascertaining the quality of minerals and other substances, as well as the dip of the strata; at the same time that it is applicable in sinking wells, &c. Mr. Ryan's Specification, in which his implements are described, was published in vol. vi. of the Second Series of the Repertory of Arts and Manufactures, and noticed in our first number, page 85.

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*Farther Remarks and Experiments on Vision under Water. From a Correspondent. With Observations in Reply, by Mr.* Nicholson.—*Phil. Jour.* No. 61.

*Facts and Observations respecting Vision under Water, and various Particulars relating to Swimming. By* James Horsburgh, *Esq.*—*Phil. Jour.* No. 63.

The first of these papers is in continuation of the remarks we briefly adverted to at page 297, No. vi. This writer affirms, that in the Thames a little above Richmond, a diver could distinguish different objects, as a white egg, a spotted egg, a piece of painted wood, &c. at the depth of near nine feet, and could readily bring up any one of them that was pitched upon. We need not relate all the particulars stated; but it appears that Mr. Nicholson, by making a general inference from particular facts, has concluded that *no man can see or distinguish under water*; while his correspondent, on the contrary, perhaps making too extended a deduction from his own observations, has concluded that the ingenious Journalist has been misled by a false hypothesis, and seems to think that *all men can see under water.*

Mr. Horsburgh, the author of the second article, whose title is given above, has long indulged in swimming as a favourite amusement: he asserts, that he has frequently, when swimming under water, seen fishes darting about in various directions, and every article on the bottom very plain. The legs and feet of

persons standing at 6 or 8 yards distance, were always visible in clear water when his head was under it; and at discretion easily taken hold of, by swimming to them under water with open eyes. As far as his experience goes, all persons can see under water; but they cannot see objects in the air while themselves are immersed.

Mr. Horsburgh corroborates the opinion of Mr. Nicholson, that men are apt to drown themselves by raising their hands and arms above the water. He likewise observes, that Dr. Franklin's remarks relative to the specific gravity of the human body in salt and fresh water, seem liable to some objections, if indiscriminately applied to all persons; there being great reason to think the specific gravity of the human species differs considerably. The following instance is adduced in favour of this opinion. When at Bombay Mr. Horsburgh was often accompanied in his favourite amusement by two gentlemen who could both swim, but neither of whom had ever tried to float on the water without motion. The best swimmer of the two could not float, lying upon his back, without using a little motion with his hands or feet, although he repeated the trial several days; when he lay without motion, his head gradually sunk till completely under water. This person was of short stature, strong and athletic. The other gentleman was of a spare make, thin, and delicate in constitution; and at the first trial floated on the surface like a cork, without any motion of hands or feet: his toes, part of his feet, knees, part of his shoulders and his head, remained above the surface, when every part of his body was at rest; whilst the stout gentleman could in no position float on the surface without a gentle motion of the hands or feet. Hence it appeared evident to Mr. Horsburgh, that the specific gravity of these persons differed considerably. Mr. H. concludes his paper with some particular observations relative to swimming, the positions of floating persons, &c. which we cannot here enter into.

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*Observations.*—There is one topic suggested by Mr. Horsburgh which we should wish to see farther pursued; we mean that of the variation in the specific gravity of different men. Mr. H.'s observation barely shews that there is a considerable difference between the specific gravities of different men, and probably between those of lusty and of spare men. This gentleman does not seem aware of the experiments on this subject made by Mr. Robertson, formerly librarian to the Royal Society, and described in vol. l. of the Philosophical Transactions. He chose ten men, such as he could procure suitable to his purpose, and assuming unity as the representative of the specific gravity of river water, the specific gravities of these men were found to be 1.001, 0.901, 0.991, 0.801, 0.900, 0.849, 0.823, 0.800, 0.997, 0.843 respectively, the mean of the whole being 0.891. Hence it would

seem that the majority of men are specifically lighter even than river water, that being the case with all the subjects of Mr. Robertson's experiments except the first, who was 1 part in a thousand heavier: this man was 6 feet 2 inches high, and weighed 161 lbs. Indeed, five out of the ten were found of a specific gravity little more than $\frac{4}{5}$ of that of river water: and of consequence, with a little presence of mind there would be no danger of such men being drowned either in river or sea water. We should be much gratified if some gentleman of leisure and ability would institute a more extensive series of experiments, with a view of ascertaining the specific gravities of men of different ages, different constitutions, and different habits of body: the resulting information would not merely be curious, but of the first importance, especially if it should be found (as is extremely probable from the limited experiments of Mr. Robertson), that all, except very corpulent persons, are specifically lighter than water. A persuasion of this kind, if once deeply fixed in the minds of men, would diminish their apprehensions, whenever they fell into water, and, of consequence, would diminish the probability of their being drowned.

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*Principles of the Science of tuning Instruments with fixed Tones. By Earl* STANHOPE.—*Repert. Arts*, No. 53, *New Series.*

IT is well known, that when a string or wire is *reduced* in length, it yields a *sharper* sound, provided that the tension of the wire be not altered. Thus, if a string or wire of uniform thickness, stretched on a well-constructed monochord, be reduced to one half of its original length, then that one half will yield the sound of that higher note, which is scientifically termed the *perfect octave*, provided that the tension of the wire be not altered. A wire of two thirds of the original length, will with the same tension yield that sound which is termed a *perfect fifth*, or *perfect quint*. So also, *three fourths* and *four fifths* of the original length, yield a *perfect fourth* and a *perfect third* respectively: and any pitch whatsoever within the compass of the monochord may be obtained by regulating the length of the vibrating wire to the exact degree which is requisite for that purpose. Thirds are divided into major and minor thirds, and each of these into other kinds, well known to musicians.

Having stated his preliminary notions, Earl Stanhope proceeds to notice what he esteems a curious circumstance with respect to every instrument whose septave is constituted of twelve fixed tones. To explain this clearly his lordship proceeds thus:—Let us suppose a keyed instrument, the lowest key of which is C, to have exactly eight Cs. Let us also suppose that there be placed, in the same room, a second, and also a third instrument;

each of which is similar to the former in every respect, except as to the method of tuning. Let us suppose that the first instrument be tuned in the following manner. Let us begin by tuning the lowest C to any given pitch. Then let us make all the successive octaves, CC, CC, &c. quite perfect: we shall have seven successive octaves, which will bring us to the upper C of this instrument. Now, let us suppose that the second instrument is tuned as follows:—Let us begin, as in the former case, by tuning the lowest C of the first instrument. Then let us make the interval between that C and the G next above a perfect quint: and then, in like manner, let us tune all the following intervals by perfect quints, until we get to C again: so shall we have twelve perfect quints, in the following order, which will bring us to the upper C of this second instrument, viz. C,G;—G,D;—D,A;—A,E;—E,B;—B,F sharp (or G flat);—G flat, D flat;—D flat, A flat;—A flat, E flat;—E flat, B flat;—B flat, F;—F,C. Now, let the pitch of the upper C in the first instrument be carefully compared with the pitch of the upper C in the second instrument, and it will be found that those two Cs are not *in unison*. For the upper C in the second instrument, which was pitched by means of the twelve perfect quints, will be found to yield a *more acute* sound than the upper C in the first instrument, which was pitched by means of the seven perfect octaves. Or, in other words, the C twelfth quint in the second instrument will be *sharper* than the C seventh octave in the first instrument. The difference of pitch between those two high Cs will be rendered far more perceptible to the ear by transferring that difference to the lower octaves. Therefore, let us suppose that the third instrument be tuned in the following manner, viz.—Let us begin by tuning the upper C in this third instrument to the same pitch exactly as the C twelfth quint, or upper C, in the second instrument. And then beginning from the upper C in this third instrument, let us tune all the other Cs in it successive perfect octaves descending. Now, if we strike one of the Cs in the third instrument, about the middle octave, or lower down, and if at the same time we strike the corresponding C in the first instrument, then the C in the third instrument which was derived from the C twelfth quint in the second instrument, will yield a *more acute* sound than the corresponding C in the first instrument which was derived from the octaves. A beating will be heard between them; and a kind of disagreeable sound will be produced, not very unlike the howling of a WOLF at a distance. Hence the difference of pitch between the C derived from the quints and the corresponding C derived from the octaves, is what is technically called, by tuners, the *wolf*.

Musicians commonly speak of the *wolf* in the singular number; but in the opinion of Earl Stanhope there are *five wolves* in the quints and major thirds taken together, in all instruments which

have twelve fixed keys in each septave: viz. one quint wolf, and four other wolves in the major thirds.

After stating these particulars, his lordship proceeds to notice the *temperament* he now proposes, and its peculiarities as distinguished from the *equal temperament*, and indeed all others. The nature of his system of tuning will appear from what follows:

1st, Middle C and C on the bass second space (reckoning upwards) tuned octaves. 2d, G on the bass fourth space, tuned a perfect quint to C, on the bass second space. 3d. E on the bass third space, a perfect third to C on the bass second space; E on the treble first line, an octave to this bass E; and E, on the treble fourth space, an octave to E on the treble first line. 4th, B above the bass staff, a perfect quint to the bass E on the third space. 5th, F on the bass fourth line a perfect quint below middle C; and F in the treble first space an octave to that bass F. 6th, B flat, above the bass staff, a perfect quint below the treble lower F. 7th, A flat, on the bass fifth line, an equi-distant, or, as his lordship terms it, a *bi-equal third* between F below and C above. 8th, E flat, in the treble first line, a perfect quint above the preceding A flat. 9th, D flat, on the bass third line, a perfect quint below A flat; then D flat below the treble staff, an octave to that D flat. 10th, G flat on the bass fourth space, a perfect quint below the treble D flat. 11th and 12th, D below the treble staff, and A on the treble second space, equi-distant or *tri-equal quints* between G on the bass fourth space, and E on the treble fourth space.

Lord Stanhope has improved the construction of the monochord, as will appear from the following account:—1st, The wire is made of steel, which does not keep continually lengthening, like brass or iron. 2dly, The whole wire forms one straight horizontal line, so that the moveable bridge can be moved without altering the tension of the wire, which is not the case when the wire pulls downwards on the bridges. 3dly, The ends of the wire are not twisted round the two stout steel pins that keep it stretched; but each end of the wire is soft soldered in a long groove formed in a piece of steel which goes over its corresponding pin. 4thly, One of those two steel pins is strongly fastened by a brass slider, which is moved by means of a screw with very fine threads, this screw having a large micrometer head minutely divided on its edge, and a corresponding *nonius*; whence the tension of the wire may be very exactly adjusted. 5thly, A slider is fixed across the top of the moveable bridge, and is moved by means of another screw with very fine threads. 6thly, The slider is adjusted to the steel rod or scale, by means of mechanical contact against projecting pieces of steel firmly fixed on that steel scale, at the respective distances specified in the monochord table. 7thly, Each bridge carries a metallic finger which keeps the wire close to the top of such bridge,

while the remainder of the wire is made to vibrate. 8thly, The vibrations of the wire are produced by touching it with a piece of cork with the same elastic force, and always at the distance of one inch from the immoveable bridge.

His lordship has likewise contrived some *tuning glasses*, which are free from the inconvenience of *beating*, so commonly experienced in tuning forks. This new apparatus consists of thirteen slips of plate-glass, each of which is exactly 6 inches long, and 2 inches in breadth. They are tuned respectively one perfect octave higher than the pitch of the keys in his lordship's monochord table. The variation in tone is occasioned by a corresponding variation in the thickness of the glass slips, between the extreme thicknesses of nine hundredths and 18 hundredths of an inch. The same brass support which terminates in three pointed corks, serves for each slip in succession; each slip is similarly placed on that support, is struck by the same cork hammer, with the same elastic force, and on the corresponding spot each time; the resulting sound is extremely pure. This simple tuning apparatus is pitched to the Stanhope temperament, and will be found useful to any careful person with a moderate ear who wishes to tune his own instruments.

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*Observations.*—Though we have been much pleased, and in some respects instructed, by Earl Stanhope's elegant and scientific essay, and would unite with every friend to science and the useful arts in warmly commending his lordship's zealous and beneficial exertions in their favour, yet we must confess we have not found so much perspicuous and useful information in this Treatise on the Principles of Tuning, as our exalted opinion of his lordship's talents and ingenuity had led us to expect. But perhaps we may be unreasonable in looking for a Treatise when the noble author only intended to give an Essay.

It is a very judicious comparison between the three instruments tuned in three different methods, by which Lord Stanhope shews the nature of that universal and unalterable imperfection in instruments with fixed keys, the modifying or attempering of which constitutes musical *temperament:* but it would not have been useless to shew, by the actual multiplication of mathematical ratios, the comparative extent of the imperfection, as well as that it is a necessary consequence of the assumed relative lengths upon the monochord (the tension being supposed invariable), which have been taken for the third, fifth, octave, &c. Thus, it is known that if we tune C, E, a perfect third; E, G sharp, or A flat (which in these instruments are the same), a perfect third; and A flat, C, another perfect third; this latter sound will be graver than the perfect octave: but this, when duly considered, can excite no surprise; for the length upon the monochord assigned to each successive third being $\frac{4}{5}$ of its respective funda-

mental, we have $\frac{4}{5}$ raised to the third power, or $\frac{64}{125}$, for the length of chord to give the octave as thus produced, whereas the perfect octave is $\frac{1}{2}$, or $\frac{64}{128}$, which must of necessity give a sharper tone than the former, the ratio of their number of vibrations being that of the denominators of the representative fractions. So also, in the case of the two instruments, one tuned by twelve successive perfect fifths, the other by seven successive octaves: the lengths of equal wires to sound perfect fifths being each $\frac{2}{3}$ of its respective fundamental, while the lengths of such wires to produce successive acuter octaves, are each $\frac{1}{2}$ the length of its fundamental, the wire for the former highest C will be represented by the twelfth power of the fraction $\frac{2}{3}$, while that for the latter will be the seventh power of $\frac{1}{2}$; these fractional powers are $\frac{4096}{531441}$, and $\frac{1}{128}$, or $\frac{524288}{68024448}$, and $\frac{531441}{68024448}$, when reduced to a common denominator: of consequence, the highest C produced by means of the twelve perfect quints, will yield an *acuter* sound, than that produced by the seven perfect octaves, the number of vibrations in the two wires being in the inverse ratio of the numerators of the resulting fractions. It also hence appears, that the imperfection resulting from tuning by the thirds is much greater than that occasioned by tuning by fifths; a circumstance on which is founded the practical maxim of many tuners, namely, in tuning by perfect thirds to make the upper note as *sharp* as the ear will bear it, while, on the contrary, when tuning by fifths, the upper notes are a little *flattened* from perfection.

Lord Stanhope says, the difference of pitch between C derived from the perfect quints, and the corresponding C derived from the octaves, is technically called by tuners the *wolf:* but we believe that the term wolf is generally applied by tuners to the most imperfect fifth their system furnishes, this being commonly between G sharp and D sharp. We should like to have seen in this Essay a succinct account of Dr. Smith's reasonings on the *beatings* of imperfect consonances, and the use to be made of them by a scientific tuner.

The objects proposed to be attained by temperament are twofold: first, that we may transpose music from one pitch or key to another (upon an instrument of fixed tones), and still have all the musical intervals as near perfection as possible: secondly, to obtain, in the compass of three or four octaves, as many correct concords of full harmony as possible; i. e. consisting of a fundamental with its major third and its fifth, direct or inverted. The maxims for attaining these objects have been very gratuitous, and many of them very inefficient. Systems of temperament have been proposed by Huygens, Ptolemy, Smith, Young, &c. The best in our estimation are, the *isotonic* or *equal* temperament, in which the lengths of wires to produce the different semitones in an octave, are so many successive geometrical proportionals be-

tween 1 and $\frac{1}{2}$; and that of Dr. Smith, which he calls *equal harmony*, where each concord, except the octave, is tempered in the inverse proportion of the product of the terms of its perfect ratio, and is very nearly equivalent to a division of the octave into 50 equal parts. We admit that the Stanhope temperament is very ingenious; but it is certainly inferior to either of these; at least his "*bi-equal thirds*" and "*tri-equal quints*" are very offensive to *our* ears. Lord Stanhope says his "mode of tuning does not produce one single offensive quint;" but surely this cannot be correct: for if he tunes perfectly *seven* of the quints, the other five must, of necessity, be more imperfect, that is, more *offensive*, than those in the equal or isotonic temperament, which in his lordship's opinion are all imperfect. There is one test, however, by which the comparative correctness of any of these systems of temperament may readily be traced: let a good violin-player, or a correct vocal performer, accompany by his instrument or by his voice, a performer upon keyed instruments tuned according to these different systems of temperament, airs in a great variety of keys being tried upon each instrument; it will then appear which of the systems requires, on the whole, the least accommodation on the part of the vocal or of the violin performer, or in which temperament he experiences the least embarrassment or constraint; and that system should be preferred, though we apprehend it will not be the system whose merits we are now discussing.

There is much ingenuity in the contrivance of the *Stanhope monochord*; but in some respects we think it inferior to the monochord proposed by Mr. Attwood. In this gentleman's apparatus the string hangs vertically, its tension being regulated by a weight suspended at its lower extremity, a little below the place where the string comes into contact with a fixed pulley; the length of the string is terminated at top by a horizontal edge: the other point of termination, which in the common monochords, as well as in many musical instruments, and in the Stanhope monochord, is a bridge over which the string is stretched, is in this construction effected by two steel edges vertically placed, that are capable of approaching, or of receding from one another, like the cheeks of a vice; these being fixed on a frame worked by micrometer screws can be easily moved in a vertical direction, so as to alter the length of the string in any desired proportion: these edges are separated occasionally by a spring in order to let the string pass freely through, when its length is altered, and are closed again so as to press the string slightly when that length is properly adjusted. By means of this construction the alteration of the tending force by the application of bridges, &c. is wholly avoided. The scale placed under the string of this monochord is divided into 100 equal parts, and each of these by a micromerer screw into 1000 equal parts; so that by the aid of a

microscope and a proper index, the length of a given part of the string may be adjusted on the monochord true to the $\frac{1}{100000}$dth part of its whole length. A more minute description of this monochord, illustrated by diagrams, is given in the Appendix to Attwood's *Treatise on the rectilinear Motion and Rotation of Bodies*, where Mr. Attwood remarks, that the method of terminating the string between metallic edges, a method which we cannot but highly approve, as both simple and effective, is due to the Rev. Mr. L. Huddlestone, of the university of Oxford. This apparatus is, we think, altogether more simple than Lord Stanhope's; and it possesses the advantage not only of accurately measuring the lengths, but the tensions likewise; while, on the Stanhope monochord, though the tensions may be very nicely adjusted, they do not seem susceptible of a very accurate admeasurement.

We greatly admire this nobleman's tuning-glasses, as we think they are a considerable improvement upon those that have been generally used by the writer of this article. His glasses are not all of the same length and breadth, like Lord Stanhope's, but all of the same *thickness*; so that their other dimensions diminish gradually. They are tuned to the isotonic temperament for every semitone from C on the first line below the treble staff, through rather more than two complete rising octaves. When used they are laid parallel to one another, and in regular order upon a cork frame, having two legs, making an acute angle, so that every slip is supported nearly at each end, while its middle parts have liberty to vibrate freely: they are struck by cork hammers with taper whalebone handles; and serve not merely for the purpose of tuning, but themselves constitute a musical instrument much admired for the sweetness and purity of its tones; though as only two hammers can be used at a time, they do not, of course, furnish more than the simplest kind of *harmony*.

We should mention that the number of the Repertory from which we have abridged his lordship's Essay, exhibits a specimen of the state to which the stereotype printing has been brought under his lordship's patronage, the Essay having been printed, by permission of his lordship, from the stereotype plates.

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*On Music. By Mr.* John Farey.—*Phil. Mag.* No. 102.

Mr. Farey's letter was suggested by the perusal of a treatise on the *Theory of Music*, by Mr. W. Hawkes, lately published, in which a temperament of the diatonic scale in keyed instruments is recommended, wherein *each ascending fifth is flattened by one fifth of a comma* as the instrument is tuned, except that the fifth above E flat, and the fifth below G sharp, are directed to be tuned *perfect*.

Among the several ways of expressing musical intervals, and comparing different systems of temperament, Mr. Farey thinks none so general or convenient, as that by the logarithms of the corresponding ratios: and according to this method he has given a table of the musical intervals in an octave upon keyed instruments, conformably to the tempered systems of Mr. Hawkes, Lord Stanhope, and Dr. T. Young, as well as those appertaining to the diatonic system, or rather to the chromatic octave, example No. 4, in Mr. Hawkes's Treatise. He thence points out a method (such as will be simple and obvious to those who are conversant in such studies), by which a person may examine any of the harmonies, and decide on the pretensions to truth and exclusive advantages claimed by the advocates for each system.

To those who wish to try Mr. Hawkes's or any other tempered system, Mr. Farey recommends a careful study of that excellent work Dr. Smith's Harmonics, and the article *Temperament* in the Supplement to the third edition of the Encyclopædia Britannica, where the correct and elegant method of tuning any system by *beats*, is thoroughly and clearly explained.

This writer objects to Lord Stanhope's temperament, on account of its occasioning transitions *from a better to a worse harmony*, which Dr. Smith considers as the principal cause of the disagreeable effects which nice ears experience in our best concerts where keyed instruments are used.

Much labour would attend the collecting of what Mr. Farey conceives to be the requisite data for determining the best general system of tones for our keyed instruments, viz. a very general and extensive search into the music, both ancient and modern, serious and gay, which is now performing, to ascertain the relative frequency of occurrence of the several chords, or harmonic intervals, which occur upon each finger key as a bass or lower note; that, if possible, the chords most frequently occurring, may be made proportionally nearer to perfection; for none can, with propriety, it is plain, be made absolutely perfect.

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*Observations.*—We agree very cordially with this ingenious gentleman in recommending Smith's Harmonics, and the article *Temperament* in the Sup. Ency. Britan. as containing very valuable information on the philosophy of musical sounds in general, and the subject of temperament in particular. Smith's work is, it is true, very irregular and indigested in its arrangement; but it is rich in important and curious matter. Another valuable article in the Sup. Ency. Britan. may be pointed out to the general reader, namely, the article *Trumpet Marine*. These two articles by Dr. Robison, and the work of Dr. Smith, certainly contain more correct and perspicuous information on the philosophical theory of musical sounds than any other performances we have

met with; not even excepting the Treatises of Malcolm, Rameau, D'Alembert, Rousseau, and Gunn.

The method of comparing different systems of temperament, by means of the logarithms of the ratios of the lengths of cords, or the logarithms of the inverse ratios of the numbers of vibrations, constituting the terms of certain intervals; possesses, in our opinion, many advantages in enabling "to decide on the pretensions" of each system proposed. Indeed, we think the best system of temperament will be much more readily ascertained by this mean, than by endeavouring to determine, as Mr. Farey likewise recommends, the proportionate frequency of occurrence of the several harmonic intervals. We must confess "we are somewhat surprised" (to adopt Mr. F.'s own language), at finding a gentleman of "his degree of information," advising that "the chords most frequently occurring may be made proportionally nearer to perfection;" because, since other chords besides these must necessarily occur in different parts of every piece of music, the ideal system now objected to cannot be adopted any more than Lord Stanhope's, "without doing mischief, and particularly, by occasioning transitions during performance *from a better to a worse harmony*."

We have, when speaking of Lord Stanhope's ingenious Essay, expressed our decided preference of the equal temperament of the isotonic scale: and we must again be permitted to repeat that it corresponds best with the requisite conditions of a temperament. Since the alterations ought to be so combined that the harmony may suffer as little as possible, it will be indispensable to retain the accuracy of the octaves, by sacrificing a little to that of the fifths and thirds: for it is nearly with respect to the octave as with regard to the unison, which, by reason of its great simplicity, is so agreeable to the ear, that that organ cannot tolerate the least defect in its precision. But the ear relaxes something of its severity with respect to less simple intervals, allowing more in proportion as they deviate from simplicity; and in this case it in a manner supplies their deficiencies, and supposes evanescent those differences which it does not appreciate. Now with regard to fifths, if we adopt it as a practical maxim, not to make a transition "from the better to the worse harmony" in cases of temperament, and since, in fact, there has been no satisfactory, or, as we think, even *plausible* reason adduced, why one should rather be altered than another, it follows that we ought to alter them equally. Thus, as the alteration is made to influence all the fifths, it will be in each of them almost imperceptible; and hence the fifth, which after the octave is the most perfect of all consonances, and which we are under a necessity of altering, is only altered in the least degree perceptible. From a like consideration it will result that all the thirds should undergo equal alterations, and that since the third is a less simple consonance than

the fifth, it will admit of a farther deviation from correctness without becoming insupportable to the ear. This practice then is consistent with the nature and object of temperament: and it is not a little curious, that it in a manner makes the anomaly which renders temperament necessary, correct itself: for, as we have seen in the observations on Earl Stanhope's paper, an acuter double octave produced by a series of thirds differs proportionally more from the analogous interval produced by octaves, than an acuter septuple octave generated by fifths does from the analogous interval generated by successive octaves; whence it is natural to infer from the anomaly itself, that the fifths should undergo a less alteration than the thirds, supposing that both must be altered, a process about which there is no question.

We have been told, it is true, that some ears will not bear any such change in the third, as this system of temperament requires: yet, admitting the fact, we should contend that it arises from disposition, or from an adaptation of the organ to a preconceived theory, and not from a principle. And we conceive it would be no more reasonable to abandon a system of temperament on this account, than to relinquish the composition of airs in a major key because some persons of a pensive turn of mind cannot listen to any music but what is in a minor key.

The subject of musical temperament not often occurring in our periodical publications, we have been tempted to speak of it rather at large. We conceive that the principles on which it reposes are more satisfactory than almost any other connected with the philosophy of music; and we have therefore developed some of them as a tribute of attachment to a science, the theory of which furnishes as much delight to the mind, as the practice does to the senses; and both when duly regarded tending to civilize the uncultivated, to soften the obdurate, to soothe the distressed, and to give additional relish to felicity.

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*Practical Rules for reducing the apparent Distance of the Moon from the Sun or a fixed Star to the true Distance, for the Purpose of ascertaining the Longitude of the Place of Observation. By a Correspondent.—Phil. Jour.* No. 62.

The rules given by this writer are all founded upon the two following well-known analogies, viz. That the rectangle of the sines of the sides containing the vertical angle : the square of the radius : : the rectangle of the sines of the differences between the half sum of the three sides, and each of those first mentioned sides : the square of the sine of half the contained angle; and : : the difference between the versed sines (or the sum or difference of the cosines) of the base and of the difference of the sides : the versed sine (or sum or difference of radius and cosine) of the

same angle. These rules are in number four: the first is avowedly similar to a method given in Keith's Trigonometry, the other three are different. The following appear to us to be the best of these three:

*Rule* II. 1. Add together the two apparent co-altitudes, and the apparent distance, and take the difference between their half sum and each of the apparent co-altitudes separately. 2. Add together the arithmetical complements of the log. cosines of the two apparent altitudes, the log. sines of the two before-mentioned differences, and the log. cosines of the true altitudes, and halve the sum. 3. Subtract from this half sum the log. sine of half the difference of the true altitudes, and the remainder will be a log. tangent. 4. Find the correspondent log. sine, subtract it from the before-mentioned half sum; and the remainder will be the log. sine of half the true distance.

*Rule* IV. 1. Add together the arithmetical complement of the log. sine of half the apparent distance and the log. sine of half the difference of the apparent altitudes, and their sum will be the log. cosine of an arc, which call A. 2. Find the log. sine of A; subtract from it the before-mentioned arith. comp. and double the remainder. 3. Add to this doubled remainder the arith. comps. of the log. cosines of the apparent altitudes, and the log. cosines of the true altitudes, and halve the sum. 4. From this half sum subtract the log. sine of half the difference of the true altitudes, and the remainder will be a log. tangent. 5. Find the correspondent log. sine; subtract it from the before-mentioned half sum, and the remainder will be the log. sine of half the true distance.

The example given at page 30 of the "Requisite Tables," ed. 2. is worked out by each of these four rules, and the results agree within 6 seconds. The assigned advantages of these rules of reduction are, that they are not difficult in practice, that they are perfectly correct, that they may be applied without using any but the common tables, that they are not incumbered with any complex distinction of cases, and that their results are void of ambiguity.

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*Observation.*—We do not think either of these methods at all superior to Dunthorne's method improved, as given at pa. 32 of the Requisite Tables,—to the method in the Appendix to Emerson's Cyclomathesis copied into Mr. Keith's book,—to that of Borda given in the stereotype edition of Callet's Logarithms,—to that at pa. 140, vol. i. of Dr. Mackay's Treatise on the Longitude, or even to that at pa. 213 of Andrew's Nautical Tables. Though the latter mentioned two methods are subject to the disadvantage of requiring peculiar tables, besides those for logarithms,

*Description of an improved Air-pump.* *By* T. Sylvester, *Esq.* —*Phil. Mag.* No. 101.

Mr. Sylvester's air-pump has neither valves nor stop-cock. He supplies their place by a slider which is shifted at every motion of the piston; in a similar manner to a stop-cock, which requires no pressure of the air to open it. It moves between two facings of leather, which lessens friction and procures a close fitting of the parts; and if, after use, it should at any time be found not air-tight, the defect may be instantly remedied by means of four screws. A strong brass plate is firmly fixed to the barrel in which the piston works, and parallel to this at a small distance beneath, which may be varied by means of four screws, is another brass plate. In the upper plate are two small holes (called G and H in the diagram, and here adopted for the sake of perspicuity) opening into the barrel, and in the lower plate two other equal holes, N and O, placed vertically beneath the former. The plates are ground smooth, faced with leather that is pierced opposite the holes, and smeared with grease. The polished brass slider has an orifice T equal to each of the former, and is placed between the plates, subject to a reciprocating motion and no other. Into the hole N is closely screwed a duct communicating with the receiver, and into the hole O another duct through which the air is discharged. Now when the hole T in the slider is between the hole N (communicating with the duct from the receiver) and G in the upper plate, the piston is drawn up, and the air rushes out of the receiver through the duct and the three holes N, T, G (which are then all vertical), into the barrel. The slider is then drawn back by a ring, so that the same hole T is between H and O; in that position the communication between the receiver and the barrel is cut off, and that between the barrel and external air is opened; consequently, by pushing down the piston the air is expelled from the barrel through the discharging duct. The slider being again shifted closes up the discharging duct and opens that from the receiver; and thus the process is continued, in the language of Mr. Sylvester, "until the receiver is exhausted." A small ridge of brass at each end of the slider prevents its being pushed or pulled too far either way. A little longer slider with two orifices may be made to serve for two barrels. And a reversed series of motions will convert the machine into a condenser.

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*Observations.*—It is truly gratifying to trace the attention which has lately been paid to the simplifying the construction of the air-pump. We conjecture that Mr. Sylvester has not seen the de-

scription of Wright's air-pump in Nicholson's Journal, and our remarks upon it in No. 4. of the Retrospect: but even if he had, there is sufficient in the present construction clearly to evince his ingenuity. We think, however, it might be improved while the principle is retained, by causing motion to be given to the slider by springs: some connexion between the springs and the handle that works the piston might give liberty to the operation of one spring when the piston was up, and to the other when the piston is down; and thus the motion of the slider be regulated by that of the piston, without separate attention and labour, as in Mr. Sylvester's contrivance. This gentleman will excuse our alluding to the looseness of the expression, "until the receiver is *exhausted*:" he, doubtless, is well aware that the receiver *cannot* be perfectly exhausted even by his air-pump; but some young readers may give full weight to the expression, on which account alone we have noticed its incorrectness.

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1. *Observations on the different Degrees of Facility with which Masses of the same Materials admit of Changes in their Temperature; with Applications of the Facts to the Construction of Pendulums. By* J. W. Boswell, *Esq.*——*Phil. Jour.* No. 38.
2. *Remarks on a Paper of Mr. Boswell's on invariable Pendulums, &c. By* J. G.—*Phil. Jour.* No. 61.
3. *On invariable Pendulums. By Mr.* J. W. Boswell.—*Rep. of Arts, &c.* No. 54, *New Series.*

I. Although the first of these papers was noticed at pa. 52 of our first volume, to which we beg to refer our readers for its contents, yet have we given its title in connexion with those of the two that follow it, since the whole are connected in a controversial point of view.

Mr. Boswell had inferred in his first paper: 1. That the greater the bulk of any body, the less will be its mutability of temperature in proportion, and, of course, the less will it alter its degree of expansion. 2. That a large globe, or a cylinder whose height is equal to its diameter, or a large cube, would have its dimensions very little changed by the fluctuations of atmospherical temperature.

II. Mr. J. G. gives it as his opinion, that these inferences are inadmissible, on account of the possibility of the partial expansion of the given body, that is, the expansion of one part independently of the remainder. Thus a bar of iron may be red hot at one end, and cold at the other, and would expand where heated; as would also Mr. Boswell's large body. This writer likewise objects to the other suggestions of Mr. Boswell, in which deal, mahogany, or metal, is recommended: and he is incapable of per-

ceiving the good effect likely to arise from filling the glass tube (intended for a pendulum rod) with semen lycopodii, or with saw-dust, or from the covering it with oiled silk.

Again, in controverting some remarks by Mr. Boswell on the pendulums of Pine and Crosthwaite, this writer gives his opinion that the partial expansion in timber by heat of the air is so great as to twist screws from their first position, so as to produce a new source of inaccuracy in pendulums, by raising the cocks which were supported by them.

This gentleman likewise animadverts on Mr. Boswell's observations relative to pyrometers; but his remarks on this point do not appear sufficiently important to justify our giving them in detail.

III. Mr. Boswell in reply to J. G. observes: 1. That though the possibility of partial expansion in certain cases is well known, yet its universality is by no means evident; and that there is great reason to think, that at low temperatures (especially when their changes are as gradual as those of the atmosphere) the tendency to partial expansion in bodies is so corrected by the cohesion of their parts as not to occasion any perceptible change. As to what takes place when the substance is heated red-hot, that is completely irrelevant to the present question, which relates merely to the effects of changes of atmospheric temperature. 2. That the use of filling the tubes with substances known to be bad conductors of heat, such as he mentioned, and of covering them with the same, of which J. G. affects to be ignorant, is obviously to prevent change of temperature at their external and internal surfaces. After Rumford and others have published so much about non-conductors of heat, to be ignorant of their use is not very creditable to writers on those subjects. 3. That if J. G.'s position relative to the partial expansion of timber were true in the degree he infers, all frame-work held by screws or nails, and particularly metal-work, must soon come asunder from the breaking or twisting of the connecting parts; at least some sign would be exhibited of this unequal movement of the body, as marks of bending on the screws or nails: but nothing of the kind having ever been noticed, shews the opinion to be fallacious. Indeed, had this cause of error subsisted, Mr. Pine's pendulum, the cocks of which were sustained by screws, must have performed worse than a common one, which is contrary to the fact.

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*Observations.*—We have given above, all that appears to us essential in this controversy; a controversy in which Mr. Boswell has manifestly the better of the argument, though he may perhaps be a *little* too sanguine in his expectations of the benefit to be derived from the adoption of massy pendulum supports. The author of these observations is perfectly ignorant of, and unknown to either of these

controvertists; but can hardly account for this attempt at exposing what was thought faulty in Mr. Boswell's paper, more than a year and a half after its publication; while there is not the remotest hint at the numerous ingenious suggestions contained in that paper, relative to circular and paraboloidal pendulums, the boxing up the pendulums from the effect of the air, the diminution of friction on rail-roads, the adoption of the circular pendulum as a regulator, &c. Such conduct as this is deserving of censure, because if a projector of improvements is to have his supposed inaccuracies magnified, while his really useful hints are not at all alluded to, a man of con mon modesty will be afraid of communicating his thoughts to the world, and many a highly valuable idea will be stifled in its origin.

After all, Mr. J. G. is not very well qualified for the task he has undertaken, since he does not appear to have thoroughly considered the nature and effect of heat, though closely connected with the present inquiry. Thus when he says, "It is *well known* that a bar of iron may be heated red-hot at one extremity without effecting any sensible change in the temperature of the other extremity," he seems not to be aware that iron is a conductor of caloric: a fact, however, which he may easily learn, by heating a bar of a foot long red-hot at one end, and then endeavouring to lift up it by his hand applied to the other end.

We could wish that Mr. Boswell would farther extend his experiments on the expansion, not only of massy supports, but of ponderous pendulums; and would beg to recommend to his notice those in the form of equilateral cones, which have a considerable theoretical advantage. A comparison of the times of vibrations of such pendulums, as well as of the change in dimensions, and of the deviations from the original shape, between the limits of temperature indicated by 20° and 100° upon Fahrenheit's thermometer, would be a task worthy of his ingenuity, and very likely to furnish beneficial results.

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*Construction of the Wheel and Pallets for Graham's Dead-beat Escapement. By Mr.* S. Bennett.—*Phil. Jour.* No. 61.

Draw the line A B, on which describe the circle B of the size of the intended swing wheel.

Double the number of the teeth which the pallets are intended to escape over (suppose 9), and add one to the sum; then find a number in the same proportion to the whole that 60 bears to 360: this fourth term will shew the number of degrees of the circle B (or the swing wheel), taken up in space by $9\frac{1}{2}$ teeth in the present case.

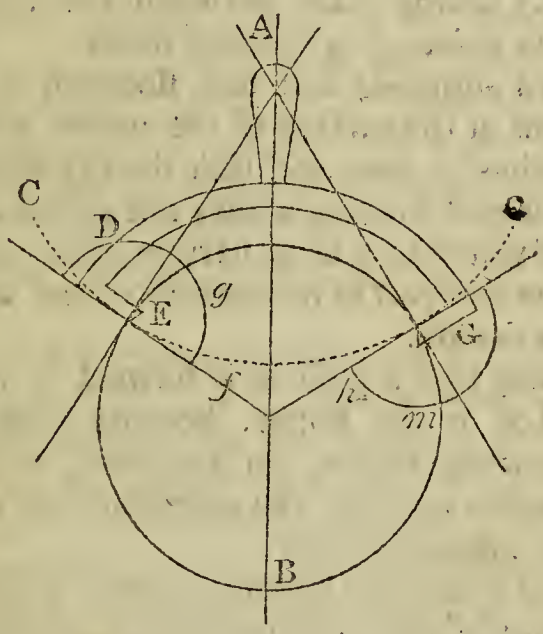
At each side of the upper intersection of the line A B with the circle, set off half of the number of degrees so found on the circle,

and from their termination draw lines to the centre of the circle; from the same points erect perpendiculars to these last lines, and prolong them till they intersect the line A B. This intersection is the centre of motion for the pallets.

From this centre draw the arch C C through the extremities of the radii before drawn. This arch shews the receiving and leaving pads of the pallets.

From the points where the arch C C intersects the circle, draw half a circle D of any size; then to find the inclination of the receiving pallet E, set off from the point f an arch of 60 degrees to g, and draw a line from g to the intersection of C C with the circle B. And for the inclination of the leaving pallet G, make a similar half circle, and from the point h set off 60 degrees to m, and from m draw a line to the other intersection of C C with B.

The figure is drawn for an escapement where the pallets escape over 9 teeth, which, according to the rule before given, will occupy 114 degrees of the swing-wheel circle, or 57 at each side of the perpendicular A B.




*Observations.*—We were glad to meet with these practical directions for the construction of a scapement, so much and so deservedly approved, as Graham's dead-beat. Mr. Bennett's mode of construction will, we doubt not, be adopted by all who can comprehend it; but it were to be wished that it had been a little more perspicuous, or rather that the author had entered a little more into detail. Conciseness is always advisable, except when it is attained by the sacrifice of perspicuity. It would be very beneficial to our artists, if some one of established judgment and considerable practice would in like manner lay down rules for the construction of the teeth and pallets of other most approved scapements; and, from the specimen before us, we wish Mr. B. would undertake it.

*Experiments and Observations on the Adhesion of the Particles of Water to each other. By Count* RUMFORD; *communicated to the French Institute Nationale.—Phil. Jour.* No. 60 and 61.

THE cause usually attributed for the flotation of small bodies of greater specific gravity than water on the surface of this fluid, is the adherence of a sufficient portion of air to them to give them buoyancy. This opinion Count Rumford shews to be fallacious by exhibiting the same flotation with small needles, minute tin globules (formed by shaking melted tin in a globular box), and little spherules of mercury in water covered with sulphuric ether, or with oil. In this last experiment the floating mercury formed a depression at the surface of the water like a small bag descending a little below its level. The small bodies did not float when alcohol was used instead of ether or oil, which the Count attributes to a union actually taking place between the alcohol and water, though apparently existing in distinct strata.

Count Rumford supposes that this flotation is caused by a thin pellicle that forms at the surface of the water, which will not permit the small bodies to pass, and that the existence of this pellicle is proved by the small floating bodies not partaking of a gyratory motion given the water in a long narrow glass vessel, and by their all vibrating when any part of the surface of the water was touched by the point of a needle.

He also supposes that a pellicle is formed at the lower surface of water as well as at the upper, because globules of mercury, passing through water resting on mercury, still preserved their figure, though compressed by the extremity of a feather, and did not mix with the lower mercury.

The viscosity of water the Count supposes is proved by globules of mercury of a much larger size retaining their figure, in a solution of gum-arabic in water, situated as before, than in pure water; and because ether or alcohol placed over the mercury gave no obstruction to small globules let fall through them, which instantly united with the lower mercury, he thinks those fluids have much less viscosity than water. This he also supposes is proved by the much greater quickness with which these fluids evaporate than water.

Substances whose particles have no adherence, though each of greater specific gravity than water, are suspended and driven about by the wind; as for example, fine sand or dust, each of whose particles, examined by the microscope, appears to be real stone: but water, from the greater adherence of its parts, is not carried off by the wind in the same manner: if it were not for this, and the pellicles formed by it at the surface, every strong wind from the sea

would cause an inundation, and the banks of lakes, seas, and large rivers, would be uninhabitable; and it is this adhesion of the parts of water which prevents its being as volatile as ether, or as fugitive as dust.

The viscosity resulting from this adhesion also enables water to hold all kinds of bodies, both heavy and light, in solution, and thereby renders it the grand vehicle of nourishment to plants and animals.

The Count calculates that spherules of gold of the 300,000th of an inch in diameter will remain suspended in water by its viscosity.

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*Observations.*—Count Rumford has not proved that viscosity and adherence of the particles of a fluid are the same thing, though he argues as if he had done so. The strong attraction of the particles of water for each other accounts sufficiently for the phenomena, so ingeniously noticed, without any viscosity being in the fluid, to which term we therefore object. Water does not indeed rise into the air, or part from it in the same manner as dust, but is however diffused through it in much greater quantities than dust ever is; it is because in this state it is not injurious to our sight or breathing that it is not noticed as dust is, but we will venture to assert, that if as much dust were carried about in the air as there is of water in a damp season, to say nothing of fogs or rain, whole cities would be buried under it, as Herculaneum was by a very similar circumstance,—a shower of ashes from a volcano.

If we could see the water contained in a strong wind from the sea, we should perceive that in fact it was sufficient to cause inundations, and that it is only prevented from doing so by its attraction to air, which causes that general diffusion of it in this vehicle, that prevents its sudden separation; which however, in some cases, takes place with a rapidity sufficient to cause very destructive inundations, as in the phenomena of water-spouts, particularly when they discharge themselves on land.

These observations will shew that much may be said on both sides of the question, and that the existence of those new agents of Nature, the viscosity of water and its pellicle, may yet be very fairly doubted: but on this subject our limits will not permit us to enlarge farther.

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*Observations on Mr. Reid's Paper on Time-pieces in the Philosophical Journal*, No. 59. Anonymous.—*Phil. Jour.* No. 61.

The object of this paper is to controvert what has been advanced by Mr. Reid relative to an escapement constructed by

Thiout in 1741, and the thermometrical compensation for balances by Harrison.

The author accuses Mr. Reid of asserting, that Thiout's invention was the first *detached escapement* made, and seven years prior to that contrived by Le Roy; and of wilfully altering the figure given with his paper from that published by Thiout (by adding a fork to the detent and making the pallet curved, which in Thiout's figure was straight), through an unjust partiality to his own statement, which the author compares to that of "a lover for his mistress, who in forming her picture cannot draw a feature without embellishing it, and after all produces a figure, from which no one can have any idea of the original." The author gives many strong arguments for the priority of this invention being attributed to M. Le Roy; which are nearly the same as those stated in the paper on the progressive improvement of time-keepers given in our last number, p. 301; and asserts, that the Academy of Sciences must have been "miserably blind" in deciding this point in Le Roy's favour, if the contrary was the fact; and mentions, that M. Camus was one of the committee who examined Le Roy's watch in 1748, who was esteemed a good judge of such matters; as a proof of which, he was employed by the French government afterwards, with Berthoud, to examine Harrison's time-keeper.

In short, he has very well established the priority of Le Roy's invention, and all that is wanted for a complete victory is an antagonist; for on minute examination it will be found, that Mr. Reid, instead of violently and partially asserting the priority of Thiout's invention, as one would be led to suppose from the observations of the author, has merely given a very humble surmise on the point, expressed with great doubt, stating, that Thiout's escapement, published in 1741, *seems a sort of detached or free one.* The author gives a figure of Thiout's escapement, which he states to be a correct copy, which differs from that described in our account of Mr. Reid's paper, in our last number, p. 317, in having the pallet straight, and the tail of the pallet-piece apparently running into a groove in the arm of the detent instead of into a fork as in Mr. Reid's figure: in other respects they are similar.

On the subject of the priority of invention of compensation balances, the author states Mr. Reid "to be animated with a violent desire of drawing extraordinary conclusions from publications generally known," in being inclined to attribute it to Mr. Harrison instead of Le Roy; but when the fact is considered, that is stated in our last number, p. 313, that the writer of the remarks in that page, has repeatedly seen in the Observatory at Greenwich the first time-pieces of Harrison, constructed with compensation bars terminated by balls, perhaps the decision of this point in favour

of Le Roy will be found not to admit of that positive and indubitable accuracy which the author is inclined to give it.

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*Observations.*—We can see no reason for the acrimony with which the author treats Mr. Reid: if he were mistaken, his error might be pointed out as clearly without any indulgence of spleen, which on such subjects is evidently altogether unjustifiable, and particularly ungenerous in a concealed observer. The triumph of the author in the accuracy of his figure of Thiout's escapement, reminds us of the Interpreter in one of Foote's plays, who is still more unintelligible than the first speaker. We have already observed, that an escapement formed like Mr. Reid's figure would shortly stop; but one according to the author's figure would be incapable of any motion whatever, as the tail of the pallet-piece is represented so completely embedded in the arm of the detent as to be quite immoveable. On the question of the priority of Harrison's compensation, we shall observe, that it seems to us that a metallic compensation in the balance was first thought of and tried by him unsuccessfully, but was first executed successfully by Le Roy.

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## *Description of Mr.* Prior's *Alarum applicable to Watches.*—*Trans. Soc. Arts,* vol. xxiii.

The striking part of Mr. Prior's alarum is formed in the common manner by a faced wheel with serrated teeth, which gives motion to pallets placed over its opposite sides, and attached to the arbor that carries the hammer; the bell is also in the common form and position. It is in the discharging and regulating parts that the novelty of this little engine principally consists, and these are uncommonly simple and ingenious. The serrated wheel is moved by a spiral spring, which is wound up by moving round its box by a button attached to its arbor; the axis of the serrated wheel comes within the spring box, and the spring is coiled round its lower extremity, and consequently tends to impel it round when wound up; but to prevent this motion till the desired moment, a pin projects from the edge of the serrated wheel, which is stopped by a projection in the axis that sustains the arm of the regulating part, as long as this arm is supported in an horizontal position; but as soon as this arm drops, the pin is disengaged from the projection of the axis, and the wheel instantly turns round and sounds the alarm. The regulating arm is sustained till the required time, by having its extremity placed between the spirals of a deep screw cut on a cylinder, lying in the same plane as its axis last mentioned, and parallel to it: on turning round this screw the arm is gradually pressed to one side by the revolving spirals, till at last it is forced entirely off the screw, and then falling down lets

off the alarum. A portion of the axis of the screw cylinder passes through the plate of the frame, and is formed into a fork (or some form of equal operation not described) into which the upper part of the key of a watch being placed, while its socket is fixed on the square part of the fusee arbor of the watch, the motion of the fusee is thereby communicated to the screw cylinder, and turning it round along with it disengages the regulating arm after a certain number of turns; the opposite end of the axis of the screw comes through a plate at the other side, and sustains an index that points on a divided dial, by the position of which the moment when the alarum is to be let off is determined. Three sliding pieces are sustained by screws to the plate first mentioned, by which the watch is firmly attached to the alarum in the required position.

It is evident that the nearer the end of the regulating arm is placed to the extremity of the screw cylinder, the sooner it will drop off; and therefore the time of its falling is determined by turning round the screw by its hand till the regulating arm comes to that part of the screw, whence a number of revolutions of the screw will be required to move it to its end proportionate to the time required to its fall, and the rate at which the fusee of the watch turns round.

A ratchet wheel and catch are attached to the spring box to hold it when winding up. There is also a catch contrived which locks on the spring box (when the spring is wound up) by a pin that falls into a hole in the box, but which appears to be superfluous when a ratchet wheel and catch are used.

There is no danger that the force required for turning the screw cylinder should at all injure the going of the watch; for this force Mr. Prior proved by experiment to be so very small as not to exceed a weight of ten grains troy.

The machinery described is sustained between two plates, kept asunder by small pillars, in the same manner in which clock-work is usually supported.

By taking notice of the hour at which you wind up your watch, and winding again in twenty-four hours, the time required for each turn of the fusee may be ascertained: in different watches this is equivalent to four, five, and six hours. The dial of the alarum is divided into 120 parts, each of which for the six-hour watch is equal to three minutes; for that whose fusee requires five hours to a turn, each division is equal to two minutes and a half; and for that of four hours, to two minutes.

The Society of Arts voted the silver medal and twenty guineas to Mr. Prior for this invention.

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*Observations.*—Machines for the above purpose were manufactured and sold more than ten years since, and the inventor had a high opinion of their utility; but the public thought differently; for although a number were made and offered for sale, very few

were purchased. In simplicity they were superior to Mr. Prior's, though the part for discharging the alarum was carried round by the fusee, not exactly indeed in the same way, but in a way equally safe and simple. If the general use of an alarum required it to be set more than twelve hours beforehand, Mr. Prior's method of discharging it at the proper time is a neat one, and we give him credit for it; but we cannot help smiling when we read, "The discovery of stopping the main spring, when wound up without a fusee, I must beg leave to say, gives me a great deal of satisfaction, and will, I hope, be useful to my brother workmen." His brother workmen are certainly obliged to him for his good intentions, but will scarcely be induced to abandon the less troublesome and more certain method of "*stopping the main spring when wound up without a fusee*" by means of the blind wheel and tooth, "a *discovery*" made long before Mr. Prior was born.—That inventive men should overvalue trivial inventions, being offsprings of their own, is a circumstance with which we so often meet, that we cease to wonder at it; but that a society, whose object it is to encourage and distinguish real merit, should give a premium and an honorary medal, and bestow no less than five engravings, as in the present case, upon a mere trifle, would have astonished us very much if we had not frequently observed the same disproportion of their rewards on former occasions.

Surely their recompenses should be confined to inventions possessing originality and utility; yet we could point out a number of models in their repository which never were of any other use than to fill up a place therein, and a variety of inventions described in their volume, which would fall under a similar censure.

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*Mr.* Antis' *detached Escapement of a Pendulum Clock.—Trans. Soc. Arts,* vol. xxiii.

In the preceding article we noticed, that the Society of Arts, &c. had bestowed five engravings, with a long list of references, upon an invention which we termed trivial. In this case they have neither given engravings nor description, although they have thought the thing worthy of a reward of twenty guineas; consequently we must refer such of our readers as may be desirous to know the merits of the invention to the model said to be deposited in the Society's rooms.

*Description of the Method for clearing Feathers from their animal Oil. By Mrs.* JANE RICHARDSON.——*Trans. Soc. Arts,* vol. xxiii.

MRS. Richardson clears feathers from their oil by lime-water, made by infusing a pound of quick-lime in every gallon of water wanted. The feathers are put into a tub, and the clear lime-water poured over them so as to cover them three inches; they are then well stirred about and left immersed in the lime-water three or four days; they are then placed on sieves till all the foul liquor drains from them; after this they are well washed in clean water, and dried on nets.

The feathers must from time to time be shaken on the nets, and as they dry will fall through the meshes.

The admission of air is recommended in the drying; from whence we conclude they are to be dried in the house. Nothing is mentioned either of the place or degree of heat in which they are to be dried.

The drying will be completed in about three weeks, after which they will only require beating for use.

Mr. Grant, a considerable dealer in feathers, was requested by the Society of Arts, &c. to examine samples of various kinds of feathers cleaned by Mrs. Richardson, and declared them perfectly well cleaned.

Mrs. Richardson obtained twenty guineas premium for communicating this method of cleaning feathers.

*Observation.*—We imagine the use of a stove, similar to that used for drying cotton, would be found very serviceable in preparing feathers in any large quantities in this way.

They might probably be as well dried in three days in such a stove as they could be in the three weeks above-mentioned without it.

*Culture of Hemp in Upper Canada. By Mr.* W. HUGHES.—*Trans. Soc. Arts,* vol. xxiii.

MR. Hughes sowed two and a half acres with hemp-seed broad cast, after plowing the land, first in April, and again on the 13th of May, immediately before sowing. The hemp was plucked on the 17th of August, and produced 1843 pounds avoirdupois weight: the soil was a black loamy clay, and no dung was used. The expenses amounted to 4*l.* 17*s.* 6*d.* Halifax currency, at 18*s.* to the pound sterling.

The sum of thirty-five dollars was voted to Mr. Hughes for cultivating hemp by the Society of Arts, &c.

*Of the Down and Sugar produced by the Cotonnier, or Cotton Plant of Canada. By Mr.* W. VONDENVELDEN.—*Trans. Soc. Arts,* vol. xxiii.

MR. Vondenvelden has sent to the Society of Arts, &c. an account of a plant that promises to be very useful.

It appears first in May much like asparagus, and is then eaten in the same manner. If left to grow, it rises to the length of 18 inches, and bears a flower resembling lilac in the beginning of August, when an abundant dew is found every morning, for about a fortnight, on its leaves and flowers, which, being shaken off about sun-rise into basins, and inspissated by boiling, yields sugar.

It afterwards produces a silky down, which the farmers there use for bedding instead of feathers.

Mr. Vondenvelden thinks the down might be also used in the manufacture of paper, if not by itself, at least by mixing it in due proportion with rags.

Mr. Vondenvelden received the thanks of the Society of Arts, &c. for this communication.

*Mr.* THOMAS VANHERMAN's *Process for making cheap and durable Paint with Fish Oil.*—*Trans. Soc. Arts,* vol. xxiii.

MR. Vanherman first details the substances used in preparing the oil for painting, and at the same time gives an estimate of the expense of each ingredient in the following statement of 298 gallons so prepared:

| | £. | s. | d. |
|---|---|---|---|
| One ton of fish oil, or 252 gallons - - - | 36 | 0 | 0 |
| 32 gallons of vinegar, at 2*s.* per gallon - - | 3 | 4 | 0 |
| 12 lb. litharge, at 5*d.* per lb. - - - - - | 0 | 5 | 0 |
| 12 lb. white copperas, at 6*d.* per lb. - - - | 0 | 6 | 0 |
| 12 gallons of linseed oil, at 4*s.* 6*d.* per gallon | 2 | 14 | 0 |
| 2 gallons of spirit of turpentine, at 8*s.* per gall. | 0 | 16 | 0 |
| | 43 | 5 | 0 |

The vinegar is prepared for the oil by putting the 32 gallons of it into a cask containing 40 gallons, with the 12 lb. of litharge, and the 12 lb. of copperas in powder, and shaking all well together twice each day for a week, after bunging up the cask.

It is then to be added to a ton of whale, cod, or seal oil, to be well mixed with it, and left to settle till next day; the clear part, which will be about seven eighths of the whole, is then to be

poured off, and to it is to be put 12 gallons of linseed oil and 2 gallons of spirits of turpentine: the whole is to be well shaken together; and after it has settled two or three days, will be fit to grind white lead, and all fine colours in, which can then only be distinguished from those ground in linseed oil by the superiority of their colour.

If the oil is only wanted for coarse purposes, the linseed oil and spirits of turpentine may be added when the vinegar is put in, and after being well stirred is at once fit for use.

The vinegar is to dissolve the litharge, and the copperas strengthens the drying quality.

The residue, or what subsides when the oil is left to settle, by the addition of half its quantity of fresh lime-water, forms an excellent oil for mixing with all coarse paint for preserving outside work.

The southern whale oil is preferred for use, on account of its superior colour and better odour.

Mr. Vanherman has given receipts for preparing a bright green, another shade of green, which he calls a subdued green, a lead colour, a stone colour, and a brown red, with the oil described.

The process for the subdued green is as follows:

"Pour six gallons of lime-water into a large tub, add to this 112 lb. of whiting, stir it well, let it settle an hour, and stir it again; then put in 112 lb. of *road-dust*, and mix it well; add 30 lb. of blue black, and then 24 lb. of yellow ochre; when all is tolerably blended, take it out of the tub and mix it well together with a labourer's shovel; then add 20 lb. of wet blue previously ground in the residue oil prepared with lime-water as described; the mass may after this be thinned with the prepared residue oil in the proportion of one quart to every eight pounds, and with the same quantity of linseed oil; it will then be ready to put into casks for use; and will not cost more than two-pence halfpenny per pound."

The bright green is formed with 112 lb. yellow ochre, 168 *road-dust*, 112 wet blue, 10 blue black, 6 gallons of lime-water, 4 gallons prepared fish oil, 7½ gallons prepared residue oil, 7½ ditto linseed oil.

The lead colour is prepared from 112 lb. whiting, 5 blue black, 28 white lead ground in oil, 56 *road-dust*, 5 gallons lime-water, 2½ ditto residue oil.

And the brown red is made by incorporating together, 8 gallons lime-water, 112 lb. powdered Spanish brown, 224 lb. road-dust, 4 gallons fish oil, 4 ditto prepared residue oil, 4 ditto linseed oil: this paint will cost scarcely 1*d*. per lb.

Yellow is prepared from yellow ochre in the same proportion as the Spanish brown.

Black is prepared by using a similar quantity of lamp black or blue black.

Stone colour is produced by mixing 4 gallons lime-water, 112 lb. whiting, 28 lb. ground white lead, 56 lb. *road-dust*, 2 gallons prepared fish oil, 3½ ditto prepared residue oil, 3½ ditto linseed oil: this colour will not cost 2*d.* per lb.

To these receipts Mr. Vanherman adds the following for *whitening* linseed oil, or making it clear and drying:

To every gallon add two ounces of litharge, shake it well every day for fourteen days; let it settle two days, then pour off the clear part into shallow pans, adding half a pint of spirits of turpentine to each gallon; place it in the sun, and in three days it will be equal to nut oil. This oil, without the turpentine, and before it is bleached, is superior to the best boiled oil.

An attestation of the very durable and beneficial nature of the fish oil paint is added, from Mr. Hill, surveyor to the Duke of Richmond; it was extensively used on the premises of his Grace, and proved equal, if not superior, to the best white lead prepared with linseed oil. Mr. Hill recommends it much for out-buildings, fences, and for plaster, stucco, and external walls.

Mr. Vanherman received the silver medal and twenty guineas for this communication from the Society for Encouragement of Arts, &c. &c.

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*Observations.*—We are inclined to approve of all compositions which preserve wood exposed to the weather more cheaply than usual, as being extremely serviceable in our variable climate, and for this reason think favourably of Mr. Vanherman's compositions. We must, however, object to his insertion of an ingredient so indefinite as *road-dust* among his colouring materials; nothing is more various in colour and composition than the dust of different roads; so much so, that in some places his receipt for a gray stone colour would produce a dark brown; and indeed the very name of such a substance is sufficient to throw an air of ridicule over a composition that doubtlessly in other respects has considerable merit. We imagine that a certain proportion of pipe clay, fine silicious sand, and a little charcoal dust, or soot, would do as well as the road-dust, and produce a more invariable effect; for even the road-dust near Mr. Vanherman will vary much at different times, as it contains more or less clay, soot, horse-dung, sand, and other numerous materials of which this matter consists, and consequently produce various shades of colour.

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*Of a Check for Carriage Wheels on Rail Roads, contrived by Mr.* Charles Le Caan.—*Trans. Soc. Arts,* vol. xxiii.

Mr. Le Caan observes, that the horse drawing on a rail road has frequently occasion to check the velocity of the carriage when

the road is at all on a declivity, that when he finds himself pressed too much he quickens his pace, which adds to the evil, and that in those cases he is very liable to fall and receive much injury from the loaded carriage. To obviate this inconvenience, Mr. Le Caan has contrived checks for such carriages, which instantly stop them when the above accident happens.

The check consists of a piece of wood about the height of the wheel, which hangs before it from a bolt or pin in the carriage, and is shaped so as to terminate in an horizontal wedge, that by the weight of the whole piece is made to fall under the wheel, and stop its motion when not prevented by being raised out of the way. The shafts by which the horse draws are moveable up and down like those of a common waggon; from these, about 18 inches from the joint, a chain passes to the check, which sustains it some inches from the wheel, when the horse stands upright in the shafts; but if he should fall and thereby depress the shafts, this chain gives way sufficiently to permit the check to fall beneath the wheel.

One of these checks is placed before each of the front wheels of the waggon; its lower extremity is shod with iron where it comes in contact with the road.

Mr. Le Caan received a premium of ten guineas from the Society of Arts, &c. for this invention.

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*Of a moveable Press for Bookbinders to expedite cutting the Edges of Books and Paper; invented by Mr.* John Isaac Hawkins. —*Trans. Soc. Arts,* vol. xxiii.

The press contrived by Mr. Hawkins for the use of bookbinders consists of two flat oblong pieces of wood (something less in breadth than the length of the book whose edges are to be cut), connected together by two screws, one in the middle, and the other at the farther extremity: the first of these forces the press together, the other opens the farther end, and thereby compresses the end which holds the book, on the same principles as cabinet-makers' hand screws.

Below the place where the book is held, stops are fastened at each side to prevent the book from falling too low, formed like two large combs, whose teeth mutually pass into the interstices of each other.

At each corner at the upper part a small block is attached on a centre, by which the press may be extended in length or breadth as required for supporting the cutting-plough beyond the book.

This hand-press is sustained in a box, when in use, by bars passing across it, so as to keep the edge of the book, that is to be cut, at an angle of about 45 degrees; a moveable bar is added be-

hind the press to keep it steady: the box holds the cuttings from the edges of the books.

When a book is fixed in this press, its front and two ends may be cut, without again moving the screws; by which the operation is performed in less time, and with less danger of cutting the book unevenly, or of a different size from that required.

Mr. Hawkins obtained a silver medal for this contrivance.

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*Observation.*—The only objection that appears against this kind of press is, that any one of this sort will do but for one size of books; but as there are but few different sizes of books in use, it can occasion no material expense to procure four or five presses of the various sizes required.

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## *Mr.* Peter Herbert's *Book-case Bolts, which fasten and unfasten by the Motion of the Lock.—Trans. Soc. Arts,* vol. xxiii.

Mr. Herbert's book-case bolts, which fasten and unfasten on locking and unlocking the doors, consist of two long vertical bolts, one at the bottom and the other at the top of the door, which are joined at the middle of the door to a little apparatus of small bars crossing each other on a pivot in such a manner, that the bolt of the lock pressing against a slider that carries two friction rollers, and impelling them against the crossed bars, makes the extremities of the cross bars extend farther from the centre of motion, and thereby shoot out the bolts: a spiral spring is attached to each bolt that draws it back again when the pressure of the slider is removed from the cross bars on unlocking the door.

The following figure, formed by letters, will give a tolerably exact idea of the apparatus of crossed bars by which the bolts are moved: ⊢◁⋊▷⊢. In this figure I I represent the bolts, X the crossed bars, and V V the smaller bars, which connect them with the bolts. In the crossing of X is a fixed pivot, which forms the centre of motion: all the other angles are moveable joints. On pressing against the sides of X the points of V V must move farther from the centre, and shoot forward each bolt in a different direction.

Mr. Herbert was voted ten guineas for this invention.

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## *On the Manufacture of Straw Plait, similar to Leghorn Plait, for Hats. By Mr.* W. Corston.—*Trans. Soc. Arts,* vol. xxiii.

The material of which Mr. Corston's plait is made is rye straw: he had five acres of poor sandy soil in Norfolk sown with two bushels of rye per acre; of the crop from this he had two

square yards pulled up from the thickest, and two more from the thinnest part; from which ten yards of plait, in all respects similar to Leghorn plait, were manufactured, and one third of a pint of rye was produced, weighing five ounces, with ten ounces of waste and refuse straw. From this Mr. Corston calculates, that one acre will produce straw sufficient for forty pieces of Leghorn plait, of fifty-five yards each in length, and employ for one week thirteen children to sort the straw, and eighty to plait it; and allowing four shillings to each, the acre will furnish 18*l.* 12*s.* 6*d.* in amount of labour bestowed on the produce, beside the value of the rye and waste straw.

From the custom-house entries it appears, that from 80,000 to 100,000 Leghorn hats, or an equal quantity of plait, are imported annually; which Mr. Corston asserts, if manufactured in this country, would give employment to full 5000 children under fifteen years of age, and afford a method of producing a valuable return from 2000 acres of poor waste land.

Mr. Corston has produced certificates from twenty dealers in hats of the goodness of the plait manufactured under his direction from rye straw, and of its being so very similar to Leghorn plait, that they should not have known that it was not the same article if they had not been informed of it.

Specimens of the hats, both knitted and sewed, are left at the house of the Society for Arts, &c. who granted Mr. Corston the gold medal for this communication.

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*Observation.*—The introduction of the manufacture of Leghorn plait is of the more value as it may furnish employment to young females at *home*, and may be made while they walk about; consequently is not liable to the same objections as the cotton and other manufactures, in which they are removed from the eyes of their friends to crowded and ill-ventilated apartments, where they remain for hours together in nearly the same posture, and at the same time have their health and morals irretrievably injured.

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*Communications on East-India Products. By Dr.* W. Roxburgh *of Calcutta.—Trans. Soc. Arts,* vol. xxiii.

Dr. Roxburgh forwarded to the Society of Arts two chests of the full-grown legumes of the Mimosa Arabica, which are of a very astringent nature, and serve for all the purposes of Aleppo galls: the trees which produce them are very numerous in Bengal and on the coast of Coromandel, where they may be procured in abundance at a cheap rate.

Dr. Roxburgh likewise recommends to the notice of the Society a species of galls produced on the tree which bears the yellow

myrabolans; they are sold in every market in India: the best and most durable yellow is dyed from them, and fixed with alum. A black is also dyed with them and ferruginous mud, and the chintz painters make their best yellow from them. They are more astringent than the fruit. Dr. Roxburgh thinks they are the *faba Bengalensis* of the old materia medica. On the leaves of the same tree he observed an insect of a similar nature to the coccus or chremes, about three eighths of an inch long and a quarter broad: the whole insect is replete with a deep yellow juice, which stains paper of a deep and rich yellow: from these insects the Doctor thinks a yellow dye might be procured as valuable as the cochineal is a red.

The second article mentioned that might be of use in this country is the *dammas*, or resin of India, produced there from various trees; which boiled with oil is used instead of pitch in the marine yards throughout India.

Third article. A drying oil from the trunk of a large tree, that grows abundantly in Chittagong, and is chiefly used in painting.

Fourth. Vegetable substances containing the astringent and tanning principles, which abound in India, probably more than in any country in the world.

Fifth. Substitutes for hemp and flax, which are very numerous in Asia.

Sixth. The coarse silks spun by the wild *tussah* and domesticated Berinda worms. The latter is soft as shawl wool, and incredibly durable.

Seventh. The very fine delicate silky wool, the produce of the trees bombax pentandria and heptaphylla. This, if still found unfit for the loom, might answer for hats, or other purposes where the softest hair of animals is employed.

Dr. Roxburgh received the gold medal for these communications.

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*Method of cleaning Silk, Cotton, and Woollen Goods. By Mrs.* Anne Morris.—*Trans. Soc. Arts,* vol. xxiii.

Mrs. Morris uses the mucilaginous liquor in which grated pulp of raw potatoes has been steeped, after the fecula has been precipitated, for cleaning silk or other stuffs.

The article to be cleaned is laid on a table on a linen cloth, and repeatedly rubbed with a sponge wet with the potatoe liquor, till the dirt is separated; after which it is well washed in clean water several times, and afterwards is dried or smoothed.

The potatoe liquor is prepared by grating raw potatoes over a vessel of water to a fine pulp, and afterwards passing the liquid matter through a coarse sieve into another vessel of water; when the fecula is precipitated the liquor is fit for use.

The coarse pulp left in the sieve is of use in cleaning worsted curtains, carpets, or other coarse goods.

The mucilaginous liquor may, besides the uses mentioned, be applied to clean oil paintings, furniture, and painted wainscots; for the latter purpose a little fine sand is to be laid on the sponge with which the liquor is applied.

Mrs. Morris received a premium of fifteen guineas for the above communication, from the Society of Arts, &c.

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*Account of Machines for spotting Muslin, and for beaming Webs: and of Types formed of Pottery for Calico Printing. Invented by Mr.* Austin *of Glasgow.—Trans. Soc. Arts,* vol. xxiii.

The machines for spotting muslin contrived by Mr. Austin are of three sorts; but all operate to impel a number of small shuttles through the warp; each of which forms a spot in that portion of the web where it has passed.

The first machine consists of a number of flat rings, each capable of turning round in the same plane, and in its proper place; a portion of each ring is cut away, which allows the remainder to pass through the warp downwards, and up again at the proper distance for the spot; a shuttle, or contrivance for holding a bobbin, is attached to each of these annular segments, which passing through the warp along with it, inserts the cotton thread that forms the spot; the annular segments revolve on a brass frame, that retains each in its proper position, and receive their motion from a rack that moves above them, and with an alternately reversed movement, having teeth cut on their outer edges to correspond to those of the rack: there are two methods inserted in Mr. Austin's description, in which the rack operates on the segments; in one the segments have a number of teeth, and in the other only three teeth each; and in this particular their respective racks answer to them.

In the second method a number of small shuttles pass horizontally through small portions of the web, at each of which they form a spot; the shuttles receive their motion from a sort of forks, of a semi-annular figure, which are suspended above them on pivots, and are capable of a pendulous motion; one end of the fork impels the shuttle forward, the other forces it back again; the forks are all attached to a moveable bar, which slides back and forwards over a fixed bar that sustains little troughs at each side of the places over the spots, for the reception of the shuttles; a piece of brass projects from the fixed bar between the legs of each of the forks, which causes their lower parts to move in the reversed direction to that of the bar to which their upper parts are attached.

For this last machine, it is necessary that the parts of the warp to be spotted should be raised above the level of the rest, or that the other parts should be depressed; but the third contrivance for the same purpose does not require this movement: the shuttles in it pass up and down obliquely, through the open part of the warp, by which means they come out at a different space of the under shade of the warp, from that of the upper shade where they entered; the troughs, or receptacles for the shuttles, which guide their direction, are attached crossways to a frame of four long bars jointed like a common parallel ruler, by moving which a little to either side required, any angle of inclination may be given to the direction of the shuttles. The apparatus for moving the shuttles up and down is not described.

The invention for beaming webs consists of a number of small hecks or rakes, each only a few inches long, attached perpendicularly to a moveable frame-work, that places them in any angle required, without any part of one crossing that of the other, by which they may be either drawn out in the same line, or closed up so as to lie parallel to each other. The contrivance by which this is effected is entirely the same as that used in the very common toy, in which little images of soldiers are made to range in different lines at pleasure, and may be conceived by supposing a frame formed similar to a succession of x's (⋈⋈⋈), with joints at the crossings and angles, having one of the small hecks fixed vertically over each of the broad lines.

The advantage of this instrument is, that by it the warp may be regularly placed on the beam for any breadth of web required, by merely expanding or contracting the frame to the proper extent, without paying any regard to the quantity or quality; which in the old way puzzles many good weavers, and obliges them to keep above 120 different sets, or scores, and quarter scores of the kind in use, which after all are not exact.

Of the machines for spotting muslins, the first and second sorts are placed on the loom, so as to slide up and down by a threadle close before the reed as they are wanted; the third sort is attached to the batten.

Mr. Austin received the silver medal from the Society for Arts, &c. for the above inventions.

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*Observations.*—Mr. Austin's contrivances are extremely ingenious and simple; the adjustable heck for beaming warps is particularly commendable, as it promises to be of great utility, and is universally applicable to all manufactures of piece goods, of every material in use.

*Description of Mr.* THOMAS PARKER's *Implement for enabling Shoemakers to work in a standing Posture.—Trans. Soc. Arts,* vol. xxiii.

MR. Parker's implement for holding shoemaker's work at a proper height to enable them to work in a standing posture, consists of a bench, a small table about four feet high, in the top of which is a perforation about 6 inches in diameter, around which an annular cushion rises about 3 inches. The last and shoe, or boot, is laid across this annular cushion, and the endless strap going round it in the usual manner, passes through the perforation downwards, and is held tight by a treadle below: a small square cushion accompanies the implement (which is found to be useful in adjusting the last and strap), together with a triangular prism of wood somewhat smaller than a last, which is used in closing boots. The annular cushion is formed upon a wooden ring, by covering it with leather, stuffed with wool or hair.

Mr. Parker received fifteen guineas premium from the Society for Arts, &c. for this invention.

*Observations.*—In our first number we have described an implement for the same purpose invented by Mr. Thomas Holden, and our observations on it apply entirely to this of Mr. Parker. We have only to add, that Mr. Parker's is more simple and more easily made, so much so, that most shoemakers could make it for their own use.

*Method of filling and emptying Canal Locks without Waste of Water. By Mr.* ROBERT SALMON.—*Trans. Soc. Arts,* vol. xxiii.

THE principle of Mr. Salmon's contrivance for filling and emptying canal locks is precisely the same as that for which Mr. Lawson Huddleston obtained a patent in 1800; the specification of which was published in the fifteenth volume of the Repertory of Arts, &c. In both methods a plunger, or cassoon, is made to descend into a chamber adjoining to, and communicating with the lock, which is in part filled with water; as the cassoon enters the chamber, the water will rise proportionally in the lock.

The mode of raising and lowering the cassoon is different in the two plans. Mr. Huddleston proposes a balance-weight attached to a spiral wheel to assist in this operation; Mr. Salmon uses inclined planes for this purpose, by which the weight is laid on or drawn off the cassoon as required.

The cassoon in Mr. Salmon's plan rises and falls in a chamber of a shape that permits it to have only a vertical motion; above it are two pair of moveable inclined planes, formed like rail roads, each about two thirds of the length of the cassoon: one pair of

these is placed at each end of the cassoon. They have one of their extremities supported by the cassoon, and the other by posts fixed to the sides of the chamber, with joints at each place; these inclined planes or rails support a carriage with four wheels, two of which rest on the rails at one end of the cassoon, and the other two on those at the other end: this carriage sustains a weight sufficient to sink the cassoon, which it effects, when it is impelled over it; but when drawn back again so that it shall be sustained by the posts, the cassoon rises, from the weight being removed from it.

A model of this contrivance, about two feet long, is to be seen at the Adelphi, the cassoon of which rises and falls about 5 or 6 inches, the carriage supports a weight of 56lbs. and the inclination of the moveable rail roads is such as to admit a weight of 2 pounds, descending 16 inches, to draw the carriage over them.

The cassoon may be made to rise and fall in the lock itself if sufficiently large for this purpose, or have its appropriate chamber at a distance from the lock, or in any position to it required, provided a free communication subsists between them.

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*Observations.*—It is obvious that wherever inclined planes, or any other of the mechanic powers, are used to raise a weight, the purpose may be effected with a power as small as desired by a proper application of them, always recollecting that in the same proportion as the force is small the time required for the operation will be great. Judging Mr. Salmon's plan by this rule, we think that it is to the small size of the model it owes its apparent efficacy; and that when tons instead of pounds would be required to be moved (as must be the case if it were executed on a large scale), what seems a cheap, strong, and durable combination of parts in the model, would be found expensive, weak, and liable to perpetual derangement in actual practice. Let any engineer calculate the construction of a carriage fit to transport 20 tons, the formation of the moveable frames sufficiently massy to sustain such a carriage, and of a cassoon strong enough to bear the repeated addition of such a load, in a single mass on a small proportion of its surface, and he will be convinced that the original expense and the cost of repairs would render the plan unadvisable. When we mention 20 tons, we consider the canal lock to be of but a small size, where the apparatus was to be used; for on such locks as are on the Grand Junction, and most other canals in this kingdom, the apparatus must be strong enough to support six times that weight. Every boat requires a weight of water to float it (in locks of the usual form), at least double that of its own tonnage, and where a second chamber is used, twice this quantity, or some equivalent to it, will be requisite: the weight necessary to sink a cassoon, large enough to elevate in this way the quantity of water required, must therefore be at least four times that of the loaded boat,

To raise so great a weight to the height necessary for sinking or raising the cassoon sufficiently to alter the elevation of the water in the lock to admit a loaded boat to pass, would require either a great force or much time, and in either case the plan would not be expedient.

Mr. Salmon's proposal for obviating these disadvantages, by sinking the cassoon by pumping water into it, shews at the best view of it a very great want of consideration; for it is very obvious that to raise the water four feet, for example, in the lock, the cassoon will require to be filled with eight feet, or double that quantity; and therefore that the lock itself without the additional chamber and cassoon, may be filled by pumping in half the time and with half the labour; so that the cassoon and chamber used in this way, would be not merely an useless incumbrance, but a very great detriment, wasteful of time, labour, and property. Though we cannot approve of the use of Mr. Salmon's plan on a large scale, we think his model as a piece of mechanism is very ingenious.

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*Account of the Telegraph contrived by Mr.* John Davis *to work Day and Night.—Trans. Soc. Arts,* vol. xxiii.

The day telegraph of Mr. Davis has seven shutters, or signal boards, one of which is larger than the rest, and slides up and down in the middle of the frame; at each side of this three of the others are placed in vertical rows, and these move on pivots in the centres of their sides, so as to assume a perpendicular or horizontal position, in the manner usual in the telegraphs erected in this country. They are worked by cords passing round pullies to horizontal sliders.

The night telegraph is formed on the same frame that supports the former, by placing a lamp beside each of the lateral shutters, and fixing one in the middle of the centre one; small vertical blinds are fixed on the frames near the lamps, which are raised or depressed by cords passing round pullies to sliders, by the motion of which the lamps may be obscured or permitted to shine at pleasure. The lamps are fixed to two rods running in grooves at each side, by which they may be raised to their places with little trouble.

There are other parts added to improve the effect of these described; these consist principally of bolts, moved by pedals, to retain the shutters in the position required, and of springs added to the cord to maintain an equable tension during the changes occasioned in them by alterations of weather.

Mr. Davis obtained the silver medal and ten guineas for this telegraph from the Society of Arts, &c.

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*Observations.*—As Mr. Davis has omitted to point out any advantages which his telegraph has over those in use, or already laid

before the public, we may be permitted to suppose he knew of none.

The day telegraph, in the only material point in which it differs from those used by our government, we think inferior to them; as when all the shutters are moved in the same way, there will be less chance of mistakes and less trouble in working them, than when some turn on pivots and others slide up and down, as in Mr. Davis's apparatus.

Of night telegraphs we have only to remark, that the lights in them should be placed far asunder, and the blinds be made to shut very close: for if these cautions are not observed, the lights will not appear distinct from each other when seen from a distance, but seem a confused glare, particularly in hazy weather. We are apprehensive that Mr. Davis's telegraph is not made with sufficient attention to these circumstances.

Mr. Davis's night telegraph is on the same principle as one described in the tenth volume of the Repertory of Arts, for which Mr. Boaz of Glasgow obtained a patent. Mr. Davis's will shew the light at both sides, the other but at one side, and this is the only material difference between them.

## CHEMISTRY AND MINERALOGY.

*A third Series of Experiments on an artificial Substance, which possesses the principal Characters of Tannin, with some Remarks on Coal. By* CHARLES HATCHETT, *Esq.—Phil. Trans.* 1806.

MANY of the resins, balsams, gum resins, and gums, when acted upon by sulphuric acid, afford the third variety of artificial tannin. The process Mr. H. used was digestion in sulphuric acid, edulcoration of the residuum, and the digestion of it in alkohol, which was separated by distillation; the residuum of this abstraction was then dissolved in cold distilled water, and the solution was examined by solution of isinglass, muriate of tin, acetite of lead, and sulphate of iron. Much sulphureous acid, carbonic acid, several of the vegetable acids (particularly benzoic acid), when the balsams were employed, and perhaps water, were produced in every case.

The sulphuric acid almost immediately dissolved the substances examined, and formed transparent brown solutions, which progressively became black; but the solutions of the balsams and of guaiacum were at first of a deep crimson, slightly inclining to brown; and neither caoutchouc nor elastic bitumen were soluble

in the acid: by a digestion of two months they were only superficially carbonized.

The gums and saccharine substances required many evaporations and filtrations before the whole of their carbonaceous residuums could be obtained.

Turpentine, common resin, elemi, tacamahac, mastich, copaiba, copal, camphor, benzoin, balsam of Tolu, balsam of Peru, asa fœtida, amber, and oil of turpentine, yielded abundance of the tannin substance; asphaltum yielded a small portion, gum arabic and tragacanth scarcely any: guaiacum, dragon's blood, myrrh, gum ammoniac, olibanum, gamboge, caoutchouc, elastic bitumen, liquorice, and manna, afforded none. Perhaps some might have been produced if the digestion had not been continued too long.

Olive oil was partly converted into the tanning substance; linseed oil with sulphuric acid formed a thick blackish brown liquid, which after digestion was partly soluble in cold water; this solution precipitated gelatine. The undissolved portion was a tough black substance which became hard in the air. It formed with alkohol a brown solution, which was rendered turbid by water; this solution when evaporated left a brown residuum, partly soluble in cold water, and then precipitated by gelatine. The undissolved portion left by the alkohol was blackish brown, soft and tenacious, and it appeared to resemble an inspissated fat oil.

White wax formed with sulphuric acid a thick black magma, insoluble in cold water. It was soluble in alkohol, but the brownish solution upon cooling was filled with a white flocculent substance. Distilled water being added to this solution, and the alkohol abstracted by distillation, a crust of spermaceti weighing 18 grains was found on the surface of the remaining liquor, which on further evaporation became pale brown, and was rendered turbid by solution of isinglass.

One hundred grains of kidney fat of veal treated with sulphuric acid formed by a long digestion a black pulpy mass: water was then added, and digested for several days. It was then filtered, a brown liquid passed the filter, which on evaporation became black, and on being filtered left a considerable portion of a blackish substance, which was added to that collected by the first filtration. This substance was insoluble in cold water, but boiling water rapidly dissolved a considerable portion of it, and the brownish black solution thus formed copiously precipitated gelatine. What remained undissolved was digested in alkohol, which dissolved the greater part of it. The solution was filtrated, but (apparently by the effect of the air) a considerable deposit was formed on the filter, which was again dissolved by alkohol. Water added to this solution separated 41 grains of a black light flaky substance, and subsequent evaporation left 30 grains of a grayish black substance, which burned with a peculiar odour;

resembling that of fat and asphaltum; it was easily melted; it was soluble in cold alkohol, and separable from that solvent by water. The black residuum mentioned above as left on the filter consisted partly of this substance and partly of coal.

Coagulated albumen and prepared muscular fibre did not afford any substance which precipitates gelatine, coal only being that which remained.

In all these experiments there appears to be a certain period when the production of the tanning substance arrives at a maximum, after which a gradual diminution of it takes place, and at length it is destroyed. In all cases this substance is identical in its nature; by the addition of a small portion of nitric acid, it is converted into the first variety, and by digestion with sulphuric acid it becomes mere coal. And thus the tanning substance obtained from resinous and other bodies by sulphuric acid is formed about the mean period of the action of that acid, while that formed by nitric acid is an ultimate effect beyond which no apparent change can be produced by any continuation of the process.

One hundred grains of elastic bitumen digested in dilute nitric acid for three weeks, left a tough and slightly elastic orange-coloured mass; fresh acid not diluted was poured on this mass, and digested till the whole was evaporated. The residuum was tenacious, orange-coloured, and partly soluble in water, forming a deep yellow liquid which copiously precipitated gelatine. The orange-coloured mass which remained undissolved was soluble in alkohol, and separable from it by water. Its properties resembled partly those of the resins and partly those of vegetable extract.

Kilkenny coal by digestion with nitric acid was converted, but with difficulty, into the tanning substance, and it did not yield any resino-extractive substance. But from 100 grains of common Newcastle coal, Mr. H. obtained (after the separation of the tanning substance) 9 grains of this resino-extractive substance; from 100 grains of cannel coal, 36 grains; and from the same quantity of pure asphaltum, 37 grains. The substances thus obtained were of a pale brown approaching to Spanish snuff colour; their internal surface was dark brown, with much resinous lustre. They did not easily melt, but on combustion they emitted a resinous odour, mixed with that of fat oil, and left a very light coal larger than the original substance. They were all soluble in alkohol, and separable from it by water, but after each precipitation a portion always remained dissolved in the water, and communicated the properties of vegetable extract. The flavour was bitter and somewhat aromatic. By digestion in nitric acid and subsequent evaporation they were converted into tanning substance, and by digestion with sulphuric acid they were converted into coal.

Mr. H. has extended his experiments on roasted substances,

and has found that the fresh peels of horse-chesnuts yield a pale brown decoction with water, which slightly precipitates a solution of isinglass. The decoction of roasted peels is dark brown, and is not rendered turbid by gelatine. The peels being re-added to this decoction, and the whole mixed with nitric acid, digested and evaporated to dryness, afforded by infusion in water a dark reddish brown liquid which copiously precipitated solution of isinglass.

The decoction of horse-chesnuts was turbid and of a pale red colour; it did not precipitate solution of isinglass, neither was this solution precipitated by the dark brown decoction of roasted horse-chesnuts. But when the chesnuts were again added to the latter decoction, and the whole digested with nitric acid until it became dry, the dark brown solution which was formed by pouring water upon this residuum copiously precipitated solution of isinglass.

From these experiments it appears, that the small portion of tannin which the peels contained was destroyed by the roasting, but that the brown decoctions of the roasted substances, although they did not act upon gelatine, were speedily made to do so, by digestion with nitric acid.

As the tanning substance is producible from coals digested with nitric acid, it appears probable that the decoctions of roasted vegetable bodies contain carbone approaching to the state of coal. This formation of coal may take place as well in the humid as in the dry way. Sulphuric acid, as we have seen, produces this effect, which also appears to take place in the putrefactive process; not that all the other principles are separated, but only so far diminished that the carbone and oxygen predominate in a state approaching to that of coal, although soluble in water, and nearly resembling the solutions afforded by vegetable substances, which have been previously roasted. It is well known that the peels of walnuts when kept in small heaps become soft, and break down into a black mass. This mass, by digestion with water, formed a blackish brown liquor, which did not precipitate solution of isinglass; but nitric acid being digested upon this mass, and the whole evaporated to dryness, a brownish orange residuum was left, which afforded with water a solution of the same colour, that yielded a tough precipitate with solution of isinglass. Roasted walnut peels digested in water afforded a brown solution, which formed a slight precipitate with solution of isinglass: the roasted peels treated with nitric acid as before, gave to water a brown colour; and the solution precipitated abundantly the solution of isinglass. These experiments corroborate what has been already remarked.

Nitric acid added to infusion of galls causes it no longer to affect the solution of isinglass, the tannin being, as was remarked in Mr. H.'s former paper, destroyed. The infusion of roasted galls yielded, with solution of isinglass, a brownish white precipi-

tate resembling that formed by the unroasted galls, but much less in quantity. Nitric acid poured into this infusion caused it to precipitate solution of isinglass of a dark-brown colour, as is done by the artificial tanning substance. When the nitric acid was digested upon it to dryness, the residuum formed with water a dark-brown solution that copiously precipitated solution of isinglass of a dark-brown colour. These experiments clearly exhibit the destruction of the natural tannin by nitric acid; the diminution and indeed destruction of it by roasting; the subsequent destruction of whatever portion remains by nitric acid, at the same time that this acid produces the artificial tanning substance: all which points were confirmed by the following experiments on oak bark.

Oak bark infused in water afforded an infusion that precipitated dissolved isinglass. Roasted bark by digestion in water afforded a much darker liquor, which precipitated muriate of tin, acetite of lead, and sulphate of iron, but had no effect upon solution of isinglass. The residuum of the roasted bark digested with the remainder of the aqueous solution, and a small portion of nitric acid, to dryness, yielded with water a brown solution, that precipitated dissolved isinglass. Oak bark was exhausted of its tannin by repeated digestion with fresh waters; the residuum was then moderately roasted, moistened with dilute nitric acid, and digested to dryness: the residuum formed with water a yellowish brown liquor, that precipitated dissolved isinglass. The roasted bark was again exhausted of this artificial tanning substance, roasted afresh, treated with nitric acid and water, and thus another brown solution was obtained, which precipitated a solution of isinglass. A third roasting and treatment of the same bark produced the same effect, so that the whole of it might no doubt have been converted into the artificial tanning substance; or the exhausted bark might have been converted into charcoal, and then treated with nitric acid, as described in the first paper; for this purpose, however, a greater quantity of acid would have been necessary. As all vegetable substances may be thus converted into an artificial tanning matter, it appears that, from the simplicity of the method, it may eventually produce some public advantage.

In the first paper it was stated that the tannin of the peat-moors was probably produced during the imperfect carbonization of the original vegetables; it appears however that this tannin is very speedily extracted and drained from the peat, as none has been detected in it. The case is the same with the oak timber from the submerged forest at Sutton. The decoction of this wood afforded only the characters exhibited by extractive matter, which was probably the same as that originally contained in the wood, but the extract yielded by the alder leaves contained in Iceland schistus is probably of secondary formation. Although peat does

not contain any tannin, yet when only digested with nitric acid to dryness, it yielded to water a solution of the artificial tanning substance in a very large proportion.

It has been generally stated, that acids have little or no action upon resinous bodies; but this assertion is now shewn to be erroneous. The acetic acid dissolves resins speedily, and they may, by proper precipitants, be separated from it pure and unaltered. Sulphuric acid almost immediately dissolves the same bodies, forming with resins, &c. transparent brown solutions, and with balsams, crimson ones. The solutions are not permanent, but are undergoing continual changes; turpentine, for example, is first changed into resin, then into the third variety of artificial tanning matter, and lastly, into coal, which is always the ultimate product. Nitric acid dissolves the resins, but the progress of its effects is entirely the reverse of those exhibited by the sulphuric acid. In the latter acid, solution precedes decomposition; but with nitric acid, the resin is first altered and then dissolved. The resin is first changed into a pale orange-coloured, brittle, porous substance, then into a product, which is intermediate between extract and resin; and lastly, this is converted into the first variety of artificial tanning substance, which is here the ultimate product.

When 100 grains of the following substances had been digested with sulphuric acid, the tanning substance and other products completely separated, and the moisture been driven off by a red heat in close vessels, there remained the following quantities of coal: From copal 67 grains, mastich 66, balsam of Peru 64, elemi 63, tacamahac 62, guaiacum 58, gum ammoniac the same quantity, amber 56, olive oil 55, balsam of Tolu 54, asa fœtida 51, wax 50, dragon's blood 48, benzoin the same quantity, olibanum 44, myrrh 40, asphaltum the same quantity; gamboge 31, gum arabic 29, liquorice 25, manna the same quantity, tragacanth 22. Elastic bitumen, as was said before, was only superficially carbonized by the sulphuric acid, so that only 31 gr. of coal were obtained; and for the same reason, only 12 gr. were procured from caoutchouc.

A much greater quantity of coal was thus obtained from the resins than was procured from them by distillation, as for example,

| | | | |
|---|---|---|---|
| Common resin by sulphuric acid | yielded | 30 gr. | by distillation $0\frac{3}{4}$ gr. |
| Mastich | | 66 | $4\frac{1}{2}$ |
| Amber | | 56 | $3\frac{1}{4}$ |

But with the gums the difference was not so great. The coals obtained by the humid process were many of them shining, hard, iridescent, and burned slowly in the manner of mineral coals; but this did not depend upon any of the acid remaining in them.

480 gr. of oak sawdust digested for a long time with 2 oz. of

sulphuric acid diluted with water, and afterwards elixiviated, was thus reduced to a granulated coal, partly pulverulent and partly clotted, weighing 210 grains. This coal was very slowly consumed, without flame, and 105 grains left about 2 grains of pale red ashes, which did not contain the smallest trace of any alkali, but only contained about 1-5th of a grain of sulphate of potash, which was probably accidental. The same quantity of charcoal made from the same oak sawdust was speedily consumed, and left brownish white ashes containing alkali, and some traces of a sulphate, probably that of potash.

Oak sawdust digested with common muriatic acid was reduced to a brownish black, pulverulent coal, which burned with some flame, emitted a slight vegetable odour, and was reduced to ashes much sooner than the coal formed by sulphuric acid, but not so speedily as the oak charcoal. The ashes had an ochraceous appearance, and were almost devoid of any saline substance, except a very slight trace of muriate of potash.

The formation of coal (in the humid way) has been variously accounted for.

1. It has been supposed that pit coal is an earthy substance of the argillaceous kind, penetrated and impregnated with bitumen.

2. The most prevailing opinion is, that it is of vegetable origin, and that the vegetables have, since their being buried under vast strata of earth, been mineralized by some unknown process.

3. Arduino conceived coal to have originated from the fat and unctuous matter of marine animals.

4. Kirwan considers coal and bitumen to have been derived from the primordial chaotic fluid.

The observations which have been made on the wood of the submarine forest at Sutton shew that vegetables, whether totally or partially buried under the earth or sea, are not merely by that means converted even into the most imperfect sort of coal. At the same time it appears that there is a regular series of gradual changes from imperfectly carbonized vegetables which retain their original structure and texture, to those in which the characters of pit-coal are found. From the alder leaves in the schistus from Iceland, vegetable extractive matter was obtained, and from many species of coals resin was obtained, which at Bovey is found in distinct masses intermixed with the strata of coal, and combined with asphaltum. It is therefore evident that these coals are of vegetable origin, especially as in the Bovey coalpits the complete transition is evidently exhibited. And in other coals or bituminous substances, it has been shewn above that an intermediate substance between extract and resin may be obtained as well from pit-coal, cannel coal, and asphaltum, as from recent vegetable resin.

Bitumen indeed has not, as yet, been truly produced by any process from resins, or other vegetable substances, although pro-

ducts resembling it in the smell, emitted during combustion, and other properties, have been obtained, but they all differed from bitumen when exposed to the action of alkohol or water. Yet there is every reason to suppose that bitumen is a modification of the resinous and oily parts of vegetables, produced by the agency of either muriatic or sulphuric acid, but most probably the latter, as common salt is not found in coal-mines, except in the vicinity of salt springs; whereas pyrites, sulphate of iron, and alum, are most commonly found in them, and the coals themselves have a sulphureous odour when burned.

The coal produced by the action of acids upon vegetables is very similar to the mineral kind, and the sulphuric acid produces this coal in much larger proportion than the mere action of fire. Oak sawdust, as we have seen, yielded 45 per centum of coal by sulphuric acid, while Proust estimates the charcoal afforded by green oak at 20 per centum, and from heart of oak at 19. The coal also which is formed by the action of the acids yields no alkalies on combustion: this it would be difficult to account for, on the supposition that fire had been the agent for converting the vegetable matter into coal; the previous elixiviation of the wood not being sufficient, as the submerged wood at Sutton, although it has had its tannin extracted from it by the water in which it lies, still retains its alkali.

It is to be hoped that these experiments may ultimately prove of great use, in preventing or diminishing the premature destruction of timber; and particular attention ought to be paid to those processes which relate to the production of the artificial tanning substance from roasted vegetable substances and from peat, as almost any refuse vegetable matter, as twigs, dead leaves, &c. will serve for the former; while peat does not require to be roasted. Besides, peat is found in many of the northern counties in such abundance, that only a small portion of it is applied to use, and then only as a fuel.

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*Remarks on the Use of Aerometers. By Mr.* Descroizilles *l'ainé.—Ann. de Chim. Juin* 1806.

This paper is principally occupied by a long account of a new instrument, which the author calls an *aérométritype*, because he says it will always serve as an infallible guide for the graduation of the scales of hydrometers. It is nothing but a strong glass bottle, with a stopple of the same, containing exactly 100 decigrammes (154 gr. troy) of distilled water at a mean temperature, and having a wide mouth. The size is adjusted by either causing the stopple to enter deeper into the bottle, or by grinding away some of the lower part of it, which is ground sloping in order to facilitate the escape of the air. For the conveniency of carriage,

the bottle is kept in a metallic case, which is adjusted so as to serve also to express the weight of the bottle and stopple when empty. Now if this bottle is filled with any liquid, the weight of the liquid will of course express its density, in comparison with water taken as 100. The size of the instrument may be increased, always observing that it should contain 100 of some particular weight.

Mr. D. thinks that this statical examination of liquids is far more convenient in many cases than hydrometers; and even in those instances where the use of hydrometers may be preferred for the sake of expedition, he thinks it would be better to graduate these instruments so as to express the excess (or defect) of the specific gravity above (or below) that of water in hundredth parts, instead of the arbitrary divisions of the hydrometers introduced by Beaume, which are now used by the chemists on the continent. Of these hydrometers there are two, the first for liquids heavier than water, and which stands at 0° in that liquid, and rises up to 66° in concentrated sulphuric acid (sp. gr. 1.84), the interval being divided into so many portions of equal length. The second for liquids lighter than water swims at 0° in a solution of 1 part of salt in 10 times its weight of water, and sinks to 10° in pure water, the scale being continued upwards, so that it generally sinks to 22° in brandy, and to 40° in alkohol.

For the purposes of commerce, however, Mr. D. proposes hydrometers with a scale of 20°, the 0° expressing the density of water, and 20° that of alkohol. He says he has not been able to succeed at present on account of the specific gravity of alkohol not being determined. Mr. Brisson makes it 0.83, or according to Mr. D.'s mode of expression, it has 17 hundredths of lightness more than water (as concentrated sulphuric acid is said by him to have 84 hundredths of heaviness more than water), but he does not despair of overcoming this difficulty.

When bottles of a certain capacity cannot be procured, he recommends the use of any convenient bottle that may be at hand, adapting to it a set of weights, so that the weight of the water it contains at a mean temperature, may represent 100, and the others the decimal and centesimal division thereof.

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*Observations.*—The graduation of hydrometers so as to express the specific gravity of the liquid in comparison with water is certainly far preferable to those arbitrary scales which are in use; but we do not think it advisable to use the density of water as a point of departure from whence the gravity may be reckoned both ways. The inconveniency of this method is already experienced in the scale of thermometers, where it is constantly necessary to prefix some mark to denote whether the ascending or descending scale is used.

As to Mr. D.'s terms of *pesanteur hydromajeure*, and *légéreté*

*hydromajeure*, they only exhibit the egregious vanity of the author, already sufficiently apparent by his assertion that if Muschenbroeck, Brisson, Blagden, Kirwan, &c. had had an instrument like his *aerometritype*, they would have saved themselves much trouble. When a similar mode of expression is desirable, it would be much clearer to say in simple words that such a liquid was so many hundred parts lighter, or heavier, than water.

But if the graduation of hydrometers to exhibit the specific gravity of the liquid is rejected as too scientific for the purposes of the arts, an adherence to the original scales of Beaume is far preferable to the assumption of peculiar scales for every distinct purpose and in every different country.

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*On the distilled Waters of inodorous Plants, on Water distilled for chemical Experiments, and on Stills in general. By Mr.* Descroisilles *l'ainé.—Ann. de Chim.* No. 170.

Mr. D. disclaims all idea of deciding the so much disputed question respecting the efficacy of the distilled waters of inodorous plants, but simply to add some facts to those mentioned by Deyeux, noticed in Number V. page 263.

He attributes the spoiling of the distilled waters of these plants, as well as that of the waters of aromatic plants, to a portion of the decoction of the plants extravasated, or ejected out of the still into the worm. As to the experiment published in the Ann. de Chimie, No. 114, p. 305 and 356, in which 4 litres (8½ pints) of water drawn off from 10 chilogrammes (20 lb. avoird.) of solanum nigrum by the water-bath, gave on evaporation 24 decigrammes (36 gr. troy) of extract, containing nitrate of potash, he considers it as a cheat put on the author by his assistant, who probably performed the distillation by a naked fire.

The ancient chemists having probably observed that during the boiling of water, a part of the liquid is flung up to the height of more than 30 centimetres (a foot) in a multitude of small jets or drops; which the eye can scarcely perceive; and further, that the decoctions were very apt to rise in boiling, not only narrowed the necks of their stills, but also made them of a considerable length. But the modern chemists have run into another extreme, and have made the necks very broad and the heads very low.

About two years ago Mr. D. perceived the inconveniency of the modern form, and since that time he has interposed a tube, 40 centimetres (15 inches) high between the boiler and its head: by this and some other precautions, he has obtained distilled waters that still preserve their odour and transparency, although they were hastily distilled by a naked fire, and have since been kept in bottles with glass stopples, frequently exposed to the sun, and

in a room which is kept constantly warm by a stove. It is well known that the orange-flower water made at Paris, although prepared with great care, will speedily become spoiled unless it is kept in vessels not exactly closed, in a cool place, and in the shade; while on the other hand, the orange-flower water brought from the south of France keeps perfectly well, although the bottles are well stopped. This difference is probably owing to the country distillers using old-fashioned stills with long necks, whereas the Parisians use modern low ones.

Some chemists have complained that water, although distilled, yielded traces of muriatic acid, and therefore have advised to distil it over again; but with stills of sufficient height, pure water may be obtained even by the first distillation.

Mr. D. promises to publish very speedily some further improvements in the formation of distilling vessels.

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*Observations.*—Most if not all the stills used in this country are constructed upon Mr. D.'s plan; those for commercial purposes being furnished with swan-neck heads; and the small family stills having a longish neck and a globular head. The low head of equal width with the mouth of the containing vessel, and with a channel round the bottom to convey the condensed liquor to the nose of the still, although to be seen in the pewterers' shops, is, in the present day, scarcely ever used here. This is what Mr. D. means by the modern heads: this form, although old-fashioned in England, being lately introduced into France as a great improvement.

The great object in diminishing the length of the neck and increasing its width was the saving it was supposed to make in the consumption of fuel; but these observations of Mr. D. evidently shew that this saving has been attended with a deterioration of the product obtained.

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*Description and Analysis of the Pyrophysalite. By Messrs.* Hisinger *and* Berzelius—*Ann. de Chim.* No. 173.

This stone is white, sometimes greenish white, and sometimes it has small spots of blue fluate of lime. It is found in oblong lumps, most commonly of an indeterminate form, but sometimes it approaches to that of an irregular rhomboid, so that the exact measure of the angles cannot be taken, but they appear to be 62° and 118°. The fracture is uneven, foliated and very brilliant in one direction, which appears to form an angle of about 90° or 100° with the axis of the rhomboid: two other less perfect cleavages may be observed nearly parallel to the faces of the rhomboid. The cross fracture has little or no brilliancy. The fragments are indeterminately angular, sharp-edged, and rather

translucid upon the edges. It scratches glass with ease, and strikes fire with steel, but it is nevertheless scratched by quartz. It is difficult to reduce to powder. Its specific gravity is 3.451. When powdered, and flung upon a heated spoon, it gives a greenish light of no duration.

It is nearly infusible by the blow-pipe; but if the heat is increased to the utmost, it grows white and opake; its surface becomes covered with small bubbles, which rise quickly, and burst if the heat is kept up. It melts easily by means of borax into a transparent colourless glass. It effervesces slightly when melted with soda, and yields a porous mass.

It was discovered by Mr. J. G. Gahn, at Finbo near Fahlun. The lumps of it are implanted into granite, from which they are separated by thin scales of mica covered over with a greenish-yellow talcy substance.

It differs from felspar, by having only one perfect cleavage, by its greater specific gravity, and by its being much more difficult to melt.

When analysed it yielded 53.25 alumine, 32.88 silica, 0.88 lime, 0.88 oxide of iron, 0.75 was lost in calcination, and 11.36 was lost in making the analysis. This latter loss was not occasioned by the presence of an alkali, but seems rather to be owing to fluoric acid, of which some traces were discovered, and which might perhaps also carry off some alumine. The very striking emission of bubbles which takes place when the stone is exposed to violent heat shews that one part of the substance is disengaged in vapour. Mr. Gahn has observed that topazes, especially the Brazilian, emit bubbles by heat similar to those produced by this stone.

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*On the making of Charcoal from Turf. By* Ant. Thillaye-Platel.—*Ann. de Chim.* No. 173.

The turf is first pressed in order to reduce its volume, then dried in the air, and after being previously warmed in a stove, it is distilled in a peculiar apparatus.

This apparatus consists in an ash-hole, moderately high and open, at the top of which is placed a grate formed of loose bars, arranged upon two supports. The opening of the fire-place is closed with a massive stopper, and in the upper part of it an iron bar is placed across the furnace from side to side to support the distilling-vessel. This vessel is an oblong chest formed of iron plates, or cast thin in iron; a small space being left all round it to give passage to the air that passes through the furnace, and after passing up the chimney, which opens over the middle of the top of the distilling-vessel, is employed to heat the stove in which the turfs are warmed before they are distilled.

One of the ends of the distilling-vessel is made so as to open in order to put in the turf, and afterwards extract the charcoal when the operation is over. An opening is of course left in the wall of the furnace opposite to this end; this opening is closed up with temporary masonry of bricks and clay. From each end of the distilling-vessel a bent iron tube proceeds, which passes through the wall of the furnace, and ends [is immersed] in a vessel nearly filled with water. From the cover of this vessel, which must be closed, another tube proceeds, and is inserted into the furnace so as to open in the fire-place just under the distilling-vessel. By this disposition the aëriform products of the turf that is distilled are employed to finish the distillation, which occasions the saving of a quarter of the fuel used for that purpose.

Mr. T. P. finds by experiment 5 or 6 parts of pressed turf are equal to 4 of wood; and that 2, 3, or even 4 parts of unpressed turf are required to produce equal effects as to heating bodies with 1 part of wood.

To avoid the smoke, he gives a draught of another apparatus for the combustion of the turf, of which we shall only say that it is merely the first rude essay towards a kitchen range, with an open chimney so badly constructed that he is obliged to have a sliding plate of iron to bring down before the fire to prevent its smoking.

Some turfs give 38 to 40 per centum of charcoal, which leaves on being burnt 17 or 18 of ashes. Some species even leave 50 of ashes, but these contain 35 of a ferruginous sand. Mr. T. P. thinks he should be able to get some turfs to yield 50 of charcoal. Oak wood he found yielded 20 to 21 per cent. of charcoal, and left 2 or 5 of ashes. Pressed turfs of a good quality may be used to bake pottery, tiles, or bricks, only they require to have a finish given them by about $\frac{1}{4}$ of the wood usually employed.

The condensible products of distilled turf are generally in two strata. The upper one is water charged with a little oil, and containing acetic acid; the under one is a heavy black oil, drawing in threads like tar, which may be employed for cart-grease, &c. By rectification these oils yield an acid which will serve to prepare iron-liquor for dyers. It is also possible to prepare verdigrise with this acid.

Verdigrise may also be prepared by employing the apples which have been pressed for cyder, moistening them with sour cyder, and putting copper plates into the mixture. And even the fruits of many wild plants might be thus advantageously employed.

*On Fat, and some Medicines into which it enters.* By Mr. H. A. Vogel.—*Ann. de Chim.* No. 173.

When well-purified hog's lard is exposed to the sun for two months, but without allowing the air to have any access to it, it acquires a rank smell and taste, and becomes yellow, but no acid is produced. If the air have access, it becomes acid. Lard melts at 32. 34° Reaum. and is not decomposed until the temperature is raised above 80°.

Lard which has been well washed yields no trace of ammonia; but if the washing was imperfectly performed, the cellular tissue that remains will give sensible traces thereof.

Lard melted with half its weight of sulphur was examined, but no sulphuric acid could be obtained from it. Part of the lard could be separated from it by fusion and decantation, and nearly the whole was separated by passing it through a fine linen. It was gray, and had a bitter, sharp, and very strong taste, it became solid sooner than usual, and blackened silver; so that some sulphur was chemically united with it. If sulphuretted lard is heated to ebullition, decanted and rapidly cooled, a part of the sulphur is precipitated; but if it was cooled slowly, then the sulphur crystallizes in fine needles. Sulphuretted lard distilled yields sulphuretted hydrogen, carburetted hydrogen, and a little carbonic acid gas, but no sulphureous acid gas was emitted; some sulphur mixed with lard was sublimed: the liquid in the receiver was milky, and let fall on cooling some crystals of sulphur: a brilliant, iridescent, very bulky charcoal, was left in the retort.

Sulphuretted hydrogen passed through melted lard had no action on it. Phosphorus was added to lard melted in a water bath; after a digestion of half an hour the undissolved part of the phosphorus was separated. The lard had acquired the smell of garlic, a disagreeable taste; it reddened tincture of litmus; it formed a very abundant black precipitate with nitrate of silver; and also precipitated the neutral nitrate of quicksilver ad minimum. Lard heated to ebullition upon phosphorus took up more of it, as far as five grains to the ounce, but a portion of it separated on cooling. When phosphuretted lard was washed with boiling water, the water became acid, blackened nitrate of silver, and precipitated lime-water; the washed fat was not acid, but still blackened nitrate of silver. Phosphuretted lard is not luminous, until the temperature is raised to 60°, and then but slightly. 12 grains of phosphorus and 2 ounces of lard distilled together very soon acquired a carbonaceous appearance; phosphuretted hydrogen was disengaged, which took fire in the receiver; more of the same, and some carburetted hydrogen, was collected in a mercurial appa-

ratus ; the receiver contained some lard which had carried over some phosphorus, and phosphuretted hydrogen, which took fire as soon as the air had access to it, and set the lard on fire also. Phosphorus dropped into a small phial quite full of melted lard, and which was immediately stopped up close, and kept in a water bath for five minutes, dissolved in the lard without rendering it acid, but it blackened nitrate of silver ; but on pouring it out, or agitating it in contact with the air, it became acid. Lard therefore is not a fit solvent of phosphorus for medical purposes.

Phosphuretted hydrogen was decomposed by melted lard, the phosphorus being absorbed : the phosphuretted lard thus obtained became acid very soon.

Muriatic acid has no action upon lard.

Nitric acid treated with lard emitted azote mixed with nitrous gas and carbonic acid gas, and the lard always became acid, and as hard as tallow ; it melted at 36° or 38° Reaum. Water boiled with this oxygenized lard, and then reduced to a small quantity, was of a citron yellow ; it had a sharp bitter taste, reddened tincture of litmus, and precipitated acetate of lead and nitrate of quicksilver. When this water was distilled almost to dryness it yielded a clear white liquor, which contained acetic acid, and did not precipitate the above metallic solutions. The residual liquid deposited on cooling a brown sticky matter, which became moist in the air ; the supernatant liquor poured off and placed in a stove, yielded crystals of mucous acid. Repeated washings did not destroy the acidity of oxygenized lard, nor alter its yellow colour. Alkohol boiled upon oxygenized lard dissolved a large proportion of it ; on cooling much of it separated, and was considerably whiter ; the undissolved lard was also whiter : the alkohol became yellow and acid ; it retained some lard in solution, which was precipitable by water. The alkohol being evaporated left an acid yellow lard, partly soluble in water. Boiling alkohol being used to wash oxygenized lard did not separate its acidity, but rather dissolved it altogether. Lime-water boiled with oxygenized lard lost its alkaline nature, and acquired a citron yellow colour. The solution was precipitated by acetate of lead, and when evaporated to the consistence of a syrup, it was rendered clear by nitric and muriatic acid, a white precipitate being flung down, and a very rank odour emitted. Barytes water acquired also an orange yellow colour from oxygenized lard ; which colour was also destroyed by acids. Sulphuric acid being added in sufficient quantity to separate all the barytes, the remaining liquid when evaporated yielded acicular crystals, which did not precipitate lime-water, were insoluble in alkohol, and were not sublimable. Lard boiled with concentrated nitric acid for some time, and water occasionally added, deposited on cooling crystals of mucous acid : beef suet also gave the same result. The lard thus oxygenized ad maximum was soft, of a brown colour, soluble in water, and still more

so in alkohol; the water it was washed with, saturated with potash, yielded acetate of potash. Rank lard, and very old suet, treated in the same manner, also contained acetic acid. The precipitate formed by acetate of lead in the water which has been used for washing this hyper-oxygenized lard, is a combination of the lard itself with the oxide of lead, to which is added a little mucous acid; when this precipitate is decomposed by sulphuric acid, the lard is separated and swims upon the liquor. This hyper-oxygenized lard is precipitated from alkohol by water. The water in which it is washed contains nitrate of ammonia.

Oxygenized muriatic acid gas passed through melted lard was absorbed in great quantity; the lard acquired considerable weight; it had become dirty white, and so soft and oily, that it might be poured from one vessel to another at 10° Reaum.: it emitted at first white acid vapours; but being exposed near two months to the air, it acquired more solidity, although not even equal to what it had at first; it was rank, not sensibly acid, and left a slightly bitter taste in the mouth. Boiling water was only able to separate a small quantity of common muriatic acid; but nitric acid separated this acid abundantly with effervescence, and in the form of white vapours: and yet the nitric acid did not decompose it any more, nor did the lard acquire more colour or solidity.

Lard acquires a green colour when exposed to the air in contact with copper, as it dissolves the oxide of copper.

Lard triturated with quicksilver did not acquire any increase of weight; so that if the quicksilver is oxidized, as some suppose, in this preparation, the oxygen is acquired from the lard and not from the air. The stronger mercurial ointment being kept melted for three hours, and then cooled, formed two very distinct strata; the upper one was perfectly white, the lower one when rubbed with hot water let go the greater part of the quicksilver, the remainder of the quicksilver retained a little of the lard which was separated by means of purified potash, and subsequent solution of the soap in alkohol. The lard was also separated from the quicksilver by boiling the ointment in water; the lard, however, remained slightly coloured, as some of the quicksilver was still retained by it. The ointment treated with muriatic acid did not yield any oxygenized muriatic acid gas. In old mercurial ointment some of the quicksilver appeared to be in a state of oxide, but the greater part was in its metallic form. When quicksilver was triturated with turpentine, it was speedily extinguished: alkohol dissolved the turpentine, and left the quicksilver in small globules. It appears therefore that the quicksilver in mercurial ointment, at least when fresh prepared, is only minutely divided; and there is reason to think that this is the case with many other preparations of quicksilver.

When lard is united with nitrate of quicksilver, it forms a yel-

low ointment, the surface of which becomes white in time; an effect which is imagined by some to be caused by the absorption of the oxygen. The melted ointment being, however, cooled in a jar of air, did not absorb any of it, although the surface became very white. Another portion of melted ointment was placed in the recipient of an air-pump, which was quickly exhausted; bubbles of air were disengaged; and the ointment at the end of some hours had a smooth surface, and retained its yellow colour. Mr. Vogel therefore imagines that the whiteness acquired by the ointment, when poured out into another vessel and cooled, is only owing to the disengagement of gas in very small bubbles, which retained by the upper surface becoming sooner cool than the interior of the mass, and thus form a white crust: when it is very slowly cooled in the same vessel as it was prepared in, all the gas is disengaged before the ointment fixes, and it remains yellow. Some ointment two years old was boiled in water; the water was rendered yellowish, and acquired a slightly bitter taste, yet it was scarcely acid, and it did not contain any quicksilver. Recent ointment treated with water afforded the same result, except that it exhibited some very slight traces of quicksilver by means of a hydro-sulphuret. From these experiments it appears that the acid nitrate of quicksilver is in fact converted in yellow nitrate or nitrous turbith, which is not simply disseminated, but really dissolved in the lard, as it is not separated by keeping the ointment a long time in fusion. Lard kept in fusion upon nitrous turbith, dissolved it, and formed the citron ointment.

Neutral nitrate of quicksilver ad minimum was flung into melted lard, bubbles of gas were disengaged, and the white nitrate was quickly turned into a yellow powder: the lard became yellow, and held quicksilver in solution. As the quicksilver was already oxidized ad minimum, it could not give out any oxygen; therefore the nitrous acid must have partly been separated from the quicksilver, and united with the lard: thus the yellow nitrate was formed which contains, according to Braamcomp and Oliva, only about 12 per centum of nitric acid.

Nitrates of silver or lead, muriate of platina, or of hyper-oxygenized quicksilver, do not produce upon lard the same effects as the nitrates of quicksilver, as they are scarcely decomposed by the lard.

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*Chemical Observations. By Mr.* J. M. Haussman.—*Ann. de Chim.* No. 173.

The hyper-oxygenized sulphate of iron has very singular properties; it is entirely insipid when it contains no water, and it acquires an astringency beyond that of all other known substances when it is dissolved in water, or let to run in the air. It also pro-

duces the most beautiful Prussian blue, and may be employed to great advantage in dying, particularly for black.

The nitrate of iron saturated with oxygen may be obtained in crystals without weakening the nitrous acid, as was asserted by Mr. Thenard. The same nitric acid which was employed in this experiment, and which is sold by Messrs. Coustou and Co. of Paris, also was employed in the preparation of oxalic acid in the large way, and by the water-bath, and whether used at 40°, or diluted with an equal quantity of water, it always produced a small quantity of a fatty substance.

The sugar was treated with the acid, either concentrated or diluted, at three operations, each time with an equal quantity of acid. The first portion rendered the liquor brown, produced a smell of burnt sugar, and some grease swam upon the residuum. The successive addition of the other two portions of acid seemed to augment the quantity of this grease; but the brown colour and smell of burnt sugar disappeared, the oxalic acid being formed in abundance, mixed with a little malic and citric acids: perhaps some acetic acid might be also carried off.

The sugar dissolved in three times its quantity of water, and boiled, did not yield any grease. As sugar is refined with bullock's blood, it is probable that some of that substance is retained during the confused crystallization of loaf-sugar, and is converted into grease by the nitric acid. Indeed when oxalic acid was prepared from whiter sugar-candy, or even double-refined loaf-sugar, no fatty matter was produced.

Fat oils do not act upon asphaltum, nor gum-copal; but when they have been made into soap and then separated by an acid, they not only dissolve those substances, but also decompose acetate of lead, and some other metallic acetates, uniting with the oxide and disengaging the acid. It is probable that they would produce the same effect with other metallic salts. In general all fats, resins, turpentines, and wax, combine easier with other substances when they have been reduced to soap, and then again recovered, than before.

Oil separated from Marseilles soap was mixed with powdered sugar, and the whole treated as for oxalic acid. At the end of the operation the oil had acquired the consistence of tallow; it also had become yellowish and rank, but still swam upon water. A second exposure to the same treatment augmented its rancidity, and gave in some degree the smell of wax; and although well washed it sunk in water, but still preserved its solubility in alkohol.

Mr. H. claims some merit in the discoveries which have been made by treating indigo with nitric acid, as he recommended that subject to the attention of chemists, in consequence of having observed the deflagration that took place during the evaporation, and the production of an odour similar to that of benzoic acid.

For the purpose of calico-printing, he now makes his solution

of indigo in the alkaline solution of red arsenic, by merely adding ground indigo to the saline liquor till a very deep colour is obtained. This colour is afterwards diluted by adding a dilute solution of caustic potash rather than water, as it retards the absorption of the oxygen from the air. A too slow absorption is caused by adding the caustic potash in too great quantity; and this is to be avoided as well in blue for pencil-work, as in the blue *des camayeux*, which is obtained by passing the stuffs that have been printed with indigo ground and mixed with a gummy solution of sulphate of iron, alternately through troughs of caustic potash, water, sulphate of iron oxidized ad minimum, and lastly through a trough of water acidulated with sulphuric or muriatic acid.

When indigo is ground and mixed with the muriatic solution of tin, with excess of acid and oxidized ad minimum, it is decomposed, and a gas of a most unsupportable odour is emitted.

Although indigo treated with the muriate of tin oxidized ad minimum without the assistance of a caustic alkali may not be of any use in dying, yet the sulphate of indigo mixed in various proportions with that muriate, after it had been mixed with sulphuric acid, is used to produce every shade of blue or green.

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## *On two Processes for making acetic Ether.* By Mr. Henry.—*Ann. de Chim.* No. 73.

Mr. Gehlen says, that the assertion of Scheele concerning the necessity of a mineral acid being present in the process for preparing acetic ether, is founded upon fact, but that a minimum of sulphuric acid will suffice.

In Germany they usually prepare acetic acid by decomposing the acetate of soda with sulphuric acid; but to avoid this source of error, some acetic acid was prepared by distilling the acetate of copper by itself: the acid thus procured did not contain a single atom of any mineral acid. 500 grammes (1 lb.) of this acid at 11° were mixed with an equal weight of alkohol at 36°; the mixture was cohobated six times, and thus 495 grammes of ether at 24° were obtained. This ether was not miscible with water, it had an agreeable odour, and reddened blue vegetable colours. No gas was disengaged during the successive distillations. The ether being rectified upon purified potash no longer reddened blue vegetable colours; it was then 25° strong, and weighed 420 grammes.

500 grammes (1 lb.) of acetate of copper in powder being put into a retort, a mixture of as much alkohol, and as much sulphuric acid previously made and grown cool, was poured on it, and the whole slowly distilled. This produced 640 grammes of ether mixed with a small quantity of sulphurous acid, some of which, in the form of gas, was also emitted during the operation. The ether

was 25½° strong, it reddened blue vegetable colours, and formed a precipitate in barytes water and in lime water. This ether was rectified upon 50 grammes of purified potash; the first 50 grammes that passed were 30° strong, the second 28°, the third 27½°, the fourth 26½°; the whole mixed together was 28°, and weighed 535 grammes.

To discover if sulphuric ether could be separated from acetic ether by distillation, 50 grammes of sulphuric ether at 56° were mixed with 200 grammes of acetic ether at 25°. The mixture after two days repose was 30° strong. About 70 grammes being distilled off, the product had a very distinct smell of sulphuric ether, and was 39° strong.

The acetic ethers obtained by the above two processes were both of an agreeable odour; they did not differ above 4° or 5° in specific gravity: the first boiled at 50° Reaum.; the second at 46°: they evaporated slowly in the air. They were both soluble in 8½ times as much water. Sulphuric acid has but little action on these ethers; it slightly colours them: the two fluids being mixed together in equal quantities, they disengage but little caloric, about 30°. Nitric acid at 46° is rapidly decomposed by acetic ethers, much nitrous gas is disengaged, and oxalic acid is found in the residual fluid.

The second process, i. e. with sulphuric acid, is less expensive, shorter, and yields more ether; at the same time it is equally evident from the success of the first process that the assertion of Scheele and Gehlen is far from truth.

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*On the Bath Waters. By Dr.* G. S. Gibbes.—*Phil. Journ.* No. 58.

Twenty-six gallons of the water from the King's bath being evaporated in a brass vessel, yielded 2252 grains of residuum. This residuum was examined by a microscope, and appeared to contain numberless black particles which were also attractible by the magnet.

It appears that iron is deposited by the Bath waters in three different states: 1. The iron tinges the glasses used for drinking the water, of a golden yellow colour, which can be scraped off: this portion seems to have been combined with carbonic acid, and to be deposited, by the avolation of that acid, in the form of ochre. 2. It forms pyritical incrustations about the reservoirs and channels of the baths. 3. It is deposited in the form of black particles, some of which appear to have a crystalline form, mixed with the sand which is brought up by the waters.

It is therefore probable that iron exists in the Bath waters in a metallic form, or, at least, approaching to it. The quantity of iron has been hitherto estimated only by observing what has been

deposited upon the drinking-glasses, in the form of yellow carbonate, or oxide; but this quantity is very inadequate to account for the effects produced by the waters on the human constitution.

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*On the supposed Production of muriatic Acid from Water by Galvanism. By Dr.* C. Wilkinson.—*Phil. Journ.* No. 58.

In consequence of Prof. Pacchioni's experiments being published, four ounces of very pure distilled water were subjected to the influence of 800 plates for 30 hours. About 2 drachms of water disappeared, and what remained evidently contained muriatic acid.

On repeating the experiment, with the precaution of having the galvanic apparatus in one room, and bringing the wires through two small holes in a door to the water placed in an adjoining room, not the slightest trace of muriatic acid was found in the residual water: and therefore it is probable that the muriatic acid arises from the acid mixture employed in the galvanic apparatus, and thus led Pacchioni into an error.

It is said that Mr. Peel discovered this acid by decomposing two ounces of water; but 1000 galvanic plates in troughs, if even replenished every 24 hours with fresh acid and water, would require three weeks to decompose this quantity of water: it is therefore to be wished that Mr. Peel's experiments had been more fully explained.

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*On the Production of Acids and Alkali in pure Water, by Galvanism. By Mr.* Charles Sylvester.—*Phil. Journ.* No. 60.

When the experiment was made, by bringing the two wires into a portion of pure water in one single vessel, not the smallest quantity of muriatic acid was formed. Mr. Wilkinson found the same result to take place. The experiments of Mr. Peel and of Dr. Pacchioni were made in the same manner; and therefore it seems most probable that they did not produce either the muriatic acid, or any alkali.

But when some of the water was put into a tube, closed at the bottom with a piece of very thin bladder, and this tube immersed in another portion of water contained in a wine-glass, then if the positive wire be inserted into the tube, and the negative wire into the wine-glass, and the process continued with a moderate sized apparatus for about half an hour, a perceptible quantity of muriatic acid will be found in the water of the tube, and a portion of alkali, probably soda, in the wine-glass. Allowing that the bladder

might have contributed to the production of the acid, whence came the alkali? One person suspects it comes from the glass.

A tube of tobacco-pipe clay, well burned, was filled with water, and when the pores of it were saturated with moisture, it was fixed upright in a platina cup also containing water. This cup was placed upon the copper end of the trough, and a platina wire connected with the zinc end reached to the bottom of the tube. Bubbles were emitted from both portions of water, and in less than ten minutes they exhibited characters which shewed that an alkali had been generated in the cup, and an acid in the tube. At the end of four hours the water in the tube gave, on adding sulphate of silver, a precipitate of muriate of that metal; and the water in the cup being evaporated to dryness, the residuum ignited, and again dissolved in water, was found to be a fixed alkali, which was more abundant than the acid.

In other experiments the acid was most predominant; sometimes the nitric acid was formed, and little or none of the muriatic. It appears therefore that the nitric and muriatic acids are formed by the oxygen, separated by the decomposition of part of the water, uniting with the undecomposed water, and that the hydrogen is then carried by the electricity through the bladder or other substance to the other wire, where it combines with the undecomposed water in the other vessel so as to form an alkali: so that both these acids and the three alkalies are, as well as water, oxides of hydrogen.

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*On the Formation of oxygenized muriatic Acid by the Voltaic Pile.*—*By Mr.* Belloni dit Monza.

The formation of oxygenized muriatic acid by the Voltaic pile may be accounted for in three ways:

1. By supposing with Pacchioni, that the muriatic and oxygenized muriatic acids are formed from water by the abstraction of some of its oxygen.

2. By supposing with Mascagni, that the positive wire furnishes oxygen, and surcharging the water with oxygen, converts it into the acids. In which case, may we not suppose that the negative wire conveys the muriatic principle?

3. By supposing that the oxygen and hydrogen disengaged from the water unites with some principle contained in the water, although not discoverable by reagents; so that an acid is produced by the action of the positive wire, and an alkali by the negative.

The purest distilled water exposed to the sun for some weeks causes a precipitation in the nitrates of lead, or of silver. It first shews traces of ammonia, and afterwards of an acid.

Water was exposed in two tubes closed at the bottom with linen, to the Voltaic pile, with gold wires: the water in the tube

connected with the negative pole was alkaline, and that with the positive was acid.

When the tubes were filled with a solution of muriate of soda and plunged into a similar solution, hydrogen was disengaged from the negative wire, and a few bubbles of air appeared on the positive wire. Oxygenized muriatic acid was produced in the positive tube, and alkali was formed in the other. When a gold wire was used on the positive side, a solution of the gold took place in lieu of the production of a free acid.

It follows from these experiments, and others not related,

1. That a platina wire on the positive side always produces in the muriate of soda oxygenized muriatic acid, and never the simple acid.

2. The saturation of the water with muriate of soda is a matter of indifference.

3. It is likewise indifferent whether the negative wire be of gold, platina, or any other metal; and whether the water in this tube be pure, or saturated with common salt.

4. An acid is never formed in the positive tube when a gold wire is employed on that side, whatever may be the wire or water on the negative side.

5. The formation of the oxygenized muriatic acid, or of the solution of gold, may be observed in less than a quarter of an hour.

6. Oxygenized muriatic acid may be obtained by a platina wire, whether the apparatus be exposed to the light or not.

7. The platina wire disengages a quantity of gas in proportion to the quantity of muriate of soda in the water; or to the force of the pile, and the length of time employed in the process.

8. The same phenomena take place if the galvanic communication is formed by several tubes, but they are weaker.

9. If the activity of the pile be increased and the poles changed, there is a disengagement of gas from the positive wire, whether it be gold or platina.

10. If the positive tube, containing a gold wire already acted upon by the acid that is formed, is made negative, the yellow colour disappears, clouds are formed round the wire, and the water becomes alkaline.

11. If the positive tube is filled with muriatic acid, it is converted into oxygenized muriatic acid; and if the negative tube is filled with the simple acid, it disappears, and the water becomes alkaline.

12. When pure water is used, the alkali makes its appearance first; but when a solution of muriate of soda is employed, the acid appears first. If two platina wires are inserted into sealing-wax in a single tube plunged into a glass of salt-water, oxygenized muriatic acid is formed.

13. Two copper wires inserted into sealing-wax in a single tube,

or in two tubes filled with muriate of soda, the negative wire evolves hydrogen, and the wire is covered with a yellow crust, instead of a green one, as when water only is used.

14. A positive gold wire, and a negative platina wire, inserted into the nitrate of potash, disengages more gas from the negative wire than from the positive; the water on the positive side becomes acid, and that on the negative alkaline.

15. Gas is also disengaged when a solution of alum is used; the water reddens litmus for a short time; but the negative pole has no signs of any alkalization.

16. A solution of muriate of ammonia only slightly reddens tincture of litmus; very little gas is disengaged from the platina wire in the positive side, and oxygenized muriatic acid is formed in the tube. The negative wire evolves much gas, and the water acquires alkaline properties.

Brugnatelli had already announced in the 22d volume of his Annals of Chemistry, that muriatic acid was formed by a gold wire from the muriates of lime, potash, and ammonia.

*Note of Professor Veau-de-Launay.*

In repeating the experiments of Pacchioni and Brugnatelli, a strong odour of oxygenized muriatic acid was once perceived, the water remained colourless, but instantly precipitated nitrate of silver. In this experiment the pile was composed of 108 pair of plates, having cloth moistened with muriate of ammonia between each pair. When nitrate of potash was used, no sensible phenomena took place.

When a slip of tin connected the water with the copper end of the pile, no signs of the muriatic acid or of alkali appeared; it produced a very light rose-red precipitate with nitrate of silver, which appeared to arise from the tin, as the extremity in the water was rendered rather black.

When both wires, either of gold or of platina, were in the same tube, only oxygen and hydrogen were disengaged, in the requisite proportions to form water. In an experiment that lasted eight days, a gramme (15½ grains) of water was decomposed, by the action of a trough of 50 pair of four-inch square plates, the cells being filled with fine sand moistened with a solution of common salt. This trough continued in action for more than a month, the liquor in the cells being renewed twice or three times a week; and its power appeared to be in proportion to the oxidizement of the metal.

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*Observations.*—The long-depending dispute respecting the production of acid and alkaline matter in water is at length completely decided by a paper lately read before the Royal Society, in which Mr. Davy has pointed out the sources of the errors that have so long obscured the subject.

As the paper is not yet printed, we can only state the principal discoveries that struck us when it was read.

The fixed alkali formed in these experiments comes from the glass, or other substance in which the water is contained. The traces of volatile alkali sometimes observed arise from the union of the nascent hydrogen in the negative tube with the nitrogen of the common air contained in the water.

The muriatic acid is either extracted from the animal or vegetable substance used in the experiment, or it arises from the decomposition of some common salt contained in the substance in which the water is contained. The origin of the nitric acid is similar to that of the volatile alkali, namely, from the nascent oxygen uniting with the nitrogen in the water.

The galvanic fluid is capable of decomposing all saline solutions, whether alkaline, earthy, or metallic; and it even extracts and decomposes the saline principles contained in solid insoluble combinations, when saline stones, &c. are used as tubes to contain the water.

In all these decompositions the acid matters are collected in the positive tube, and the alkaline or alkalino-earthy matters, with the metallic oxides in the negative. Moreover, if an acid is put in the negative tube, it will be transferred into the positive, even through alkalies contained in an intermediate tube. In like manner, alkalies will be transferred from the positive tube into the negative, even although an acid is interposed.

Galvanism is therefore a powerful instrument of analysis. By it Mr. D. detected saline matter in water that appeared to be pure by the usual tests, and his suspicions were confirmed by the slow distillation of the fluid. He was also able to separate the saline ingredients from muscular flesh, vegetable matters, gypsum, sulphate of barytes, fluate of lime, zeolite, lepidolite, and even agate.

As is usual with those who discover a principle of such extensive application, Mr. Davy endeavours to overthrow the received theory of chemical attraction, and affects to consider this attraction as dependent upon the electric attraction and repulsion of the constituent principles of the compounds. This, however, appears, as far as we can at present judge, to be liable to the same objection as the Indian theory of the support of the earth on the back of an elephant. Upon what then does the elephant stand? on a tortoise. And on what stands the tortoise? I—I—I do not know. So in Mr. Davy's new theory. On what do the combinations and decompositions depend? On their chemical attractions. On what do their chemical attractions depend? On the electrical states of their component parts. But on what do these depend? The only answer must be, I do not know. So that this theory is in reality only a multiplication of causes, which is against the rules of sound philosophy.

*On the spirituous Liquors provided for Troops. By Mr.* PARMENTIER.—*Ann. de Chim.* No. 175.

IT is usual in France to rectify the brandy so far that it requires the addition of water in order to become fit for drinking. The retailers distinguish the strength of these spirits by the terms 3—5, 3—6, 4—7, 5—9, and 6—11; in which the first number expresses the number of pints (or gallons) of the spirit, which when added to water, will yield a number of pints (or gallons) of the usual strength equal to the second number.

The quality of the water thus mixed with the rectified spirit is not indifferent. Well-water is far the best, and in winter it should be warmed to 25° or 30° Reaum. If the water is not clear the mixture will be turbid, but a handful of well-washed sand flung into it will carry down the impurities. As the mixture is usually deficient in colour, the addition of burnt sugar is used, which not only colours the spirit, but also gives it a taste similar to that of old brandy. If, however, the mixture is too high coloured, skimmed milk is used to get rid of this inconveniency.

Weak brandy may be rendered stronger by the addition of alkohol. It is however more usual to lower the strength of the stronger brandies; except in countries where the vine is not cultivated, and where the alkohol from cider, perry, or grains is employed to adulterate the weak brandy imported into those countries; but it is scarcely possible entirely to disguise the taste of these additions.

When alkohol is first mixed with water, it has not the taste of brandy, nor is it homogeneous; the temperature of the mixture is raised, and it requires about 15 days to become perfectly homogeneous, and then it is much softer to the taste, and more agreeable. The acetous and malic acids which are usually contained in brandy are by no means essential to its composition; perfumers, and the more celebrated makers of *liqueurs*, separate them with the utmost care. The addition of volatile alkali lately proposed as a means of giving new brandy the flavour of old, is founded on the neutralization of those acids, which although found in new spirit, disappear after a certain length of time. Hence the mixture of alkohol with water may be adopted as a means of forming brandy of the proper strength, when the saving of the expense of carriage is an object of consideration. The best proportion in order to form brandy of 18° of Cartier (which is the proper strength for distribution), is 10 parts of alkohol at 33°, and 8 parts of water at the temperature of 10° Reaum. The mixture must be frequently agitated, and left for 12 or 15 days before its density is examined. The use of hydrometers with an

attached thermometer ought to be adopted in the army to ascertain the strength of the spirit delivered out. It is however far preferable to issue the spirits manufactured in the country, from whatever material they may be obtained, provided they do not exceed the proper strength, nor fall considerably short of it, than to transport from a distance either alkohol or other spirits. And even in regard to ammunition bread, it is far better to deliver out that which is usual in the country, than to adopt a general rule for its composition, which is frequently productive of heavy expense and many abuses in the commissary's department.

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## *Experiments on the different Kinds of Quinquina. By Mr.* Vauquelin.—*Ann. de Chim.* No. 176.

There are several kinds of quinquina employed in medicine; but the bark of cinchona officinalis, the red quinquina sometimes called quinquina Pitton, and the yellow quinquina, are the most usual: the other kinds are seldom found in the shops.

Mr. Seguin has stated that the species of quinquina which are febrifuge precipitate tannin, but those which do not possess that quality precipitate gelatine: but this criterion is by no means just.

Mr. Vauquelin has examined as many of the different species as he could procure. All of them were examined by an infusion made of 4 ounces of the bark with 2 litres ($4\frac{1}{4}$ wine pints) of water at 12°.

The yellow quinquina is pale yellow; it is more bitter and less astringent than the red. Its fracture is partly woody and partly resinous. It is very slightly rolled up. It is sometimes confounded with the bark of angustura. The infusion is yellow, very bitter, and slightly astringent. It abundantly precipitates isinglass. It renders the solution of sulphate of iron green like bile, and after some time forms a precipitate of the same colour. It precipitates antimoniated tartrite of potash of a yellowish white. It throws down oxalate of lime on being added to oxalate of ammonia. It reddens tincture of litmus.

When the precipitate by glue was separated, the infusion had lost its colour and astringency, but was still bitter. It became green as before, but more yellow, with sulphate of iron. It also gave a white precipitate with emetic tartar.

When the precipitate by emetic tartar was separated, the infusion still precipitated glue and sulphate of iron, but less abundantly. The precipitate formed by emetic tartar was rendered green by sulphate of iron.

The decoction afforded nearly similar results. It also precipitated the sulphate of copper of a reddish yellow colour, and the acetate of lead, yellowish white; the same as the infusion.

The *quinquina of Santa Fé* is externally gray, but red within. It is thick, slightly rolled up, astringent, and a little bitter. Its infusion is much redder than that of the yellow kind. It precipitates glue in reddish flakes, and the infusion of yellow quinquina very abundantly in red. It does not precipitate emetic tartar, but it precipitates sulphate of iron of a fine deep green. It reddens litmus, and throws down oxalate of lime when added to oxalate of ammonia. It precipitates both acetate of lead and sulphate of copper of a reddish brown. The decoction produced effects nearly similar; but it did not become turbid on cooling like that of yellow quinquina. As the substance thus separated from the latter is the cause of the metallic precipitates, except that from emetic tartar, it appears that this kind contains less of this principle, as well as none of that which precipitates emetic tartar; we may also assure ourselves that it is a weaker febrifuge.

The infusion of *gray quinquina* (called "*superieure*") is almost colourless; it is bitter and astringent. It precipitates glue white, tan red, emetic tartar very abundantly and white, sulphate of iron very fine emerald green. It does not produce any change in the infusion of yellow quinquina.

The infusion of the quinquina called *gris-canelle* is deep red; it is bitter and astringent. It precipitates glue of a yellowish brown, and gives a green with sulphate of iron. It does not precipitate emetic tartar, not infusion of *quinquina gris superieure*, nor the infusion of tan, but it precipitates infusion of yellow quinquina in yellowish brown. The precipitate dries easily, swells by heat, exhales an odour like animal substances, and leaves a spongy coal. These vegetable infusions, precipitated by one another, had no longer any action upon emetic tartar, but they still precipitated glue, and the infusion of yellow quinquina precipitated by glue still precipitates emetic tartar.

The red quinquina is erroneously called "*quinquina Pitton.*" It is darker than the c. officinalis, usually very thick, and not rolled up. Its fracture is fibrous and not resinous. It is astringent, but very slightly bitter. Its infusion is slightly orange; it precipitates glue reddish, emetic tartar yellowish white, infusion of quinquina *gris-canelle* brown, sulphate of iron green. It acts upon the other metallic solutions like the other species.

A gray quinquina, which appeared to be quinquina de Loxa, was very thin and rolled up; it came probably from young trees, or branches; the colour of its infusion was like Malaga wine. It had an astringent and bitter taste. It precipitated glue white, tan reddish yellow, yellow quinquina gray, emetic tartar yellowish white, sulphate of iron green, and the acetate of lead white. It did not precipitate sulphate of copper, nor the infusion of quinquina of Santa Fé. This kind ought to be very efficacious in medicine.

The infusion of flat gray quinquina was coloured like Malaga

wine; it had a faint taste without astringency or bitterness. It precipitated yellow quinquina brown, sulphate of red oxide of iron green. It did not affect emetic tartar, glue or quinquina canelle. From which it appears that this is not a true quinquina, nor even possessed of any febrifuge properties.

One hundred grammes of a yellow quinquina (cinchona pubescens Walh.) infused in cold water yielded a golden coloured liquor, very bitter, and frothing by being shook. Tincture of galls formed a precipitate with it, which was redissolved on adding more tincture, but water made it again appear. The liquor also precipitated emetic tartar, and nitrate of quicksilver yellowish white. It changed sulphate of iron to a fine green, without precipitating any thing. It did not affect glue, nor redden tincture of litmus. By evaporation it left a rose-coloured substance, and afterwards a brown one. The brown extract was very bitter, soluble in warm water, and in alkohol. The watery solution was precipitated by galls, emetic tartar, and nitrate of quicksilver, and it rendered sulphate of iron green. The oxymuriatic acid lost its peculiar odour, and formed a flocculent precipitate. It was not precipitated by glue, sulphuric acid, or acetous acid, nor did it exhale ammonia by the addition of potash. By distillation it yielded water, ammonia, and a purple oil which did not colour alkohol; the charcoal on incineration contained lime and oxide of iron. This is probably the efficacious principle in the cure of fevers. The liquor left after the evaporation treated with alkohol yielded to it more of this brown substance, and left a thick mucilage, without odour or colour, very soluble in water, and furnishing lamellar crystals of salt of quinquina.

The bark of the cinchona officinalis is the most ancient kind of quinquina. It is externally gray, internally red. It is thin and rolled up. It has a shining resinous fracture, slightly fibrous. It is astringent and bitter; its powder is reddish yellow with a shade of gray. It gave by infusion in cold water a lighter coloured and more mucilaginous liquor than the last. This infusion slightly reddened tincture of litmus, and presented the same appearances with reagents as the former. On evaporation it yielded a similar deposit: the supernatant liquor, after the matter that coloured it was separated by alkohol, afforded crystal of salt of quinquina. The residue of the first infusion being treated with hot water, precipitated galls and nitrate of quicksilver, and rendered sulphate of iron green, but it did not affect tartar emetic, or glue.

The cold infusion of *cinchona magnifolia* was ruby red, a little mucilaginous, slightly bitter, but very astringent. It did not redden tincture of litmus. It was not precipitated by galls or emetic tartar. Glue precipitated it abundantly. Sulphate of iron rendered it green like oxide of chrome; the oxymuriatic acid turned this to a dirty green. Is also precipitated the cold infusion

of c. pubescens, and c. officinalis. The second cold infusion of this quinquina did not precipitate glue. The infusion evaporated to an extract was partly soluble in alkohol, and the solution diluted with water was similar in its effects to the infusion. The part insoluble in alkohol was red, and blackened in the air. It redissolved in water, the solution was not precipitated by glue or galls, but it precipitated emetic tartar and nitrate of quicksilver. It also rendered sulphate of iron green. It yielded ammonia by distillation.

Another kind of quinquina, without any name, yielded a lighter coloured infusion than the last, but it was more bitter and less astringent. It reddened tincture of litmus; it did not precipitate galls nor emetic tartar, but it precipitated glue and nitrate of quicksilver, and rendered sulphate of iron green. In general it resembled quinquina magnifolia.

The true quinquina Pitton strongly resembles the quinquina of Saint Domingo that was analysed by Fourcroy in colour, form, and extreme bitterness. Its cold infusion was the colour of venous blood. It precipitated tincture of galls, emetic tartar, nitrate of quicksilver, and sulphate of iron. It was not affected by glue. Oxymuriatic acid formed a precipitate with it, but not any other acid. The residuum by evaporation was partly soluble in alkohol, and the solution resembled the original infusion. The insoluble part was gray and earthy.

The following species of quinquina were brought over by Humboldt and Bonpland:

The quinquina of Loxa, from branches of two years old, collected for the King of Spain, was externally gray, yellowish within, thin, rolled up, bitter and astringent. The infusion was reddish yellow; it precipitated galls, emetic tartar, and acetate of lead in yellowish white, iron blueish green, oxalate of ammonia white, and glue in white flocks. The precipitates by glue and emetic tartar were redissolved by an excess of the infusion. This kind is probably of great efficacy.

The white quinquina of Santa Fé is externally rusty yellow, internally darker; it is flat and thick. It has a granular fracture like beech bark. It is neither bitter not astringent. The cold infusion was of a deeper yellow than the last. It did not precipitate galls, emetic tartar, or glue. It rendered sulphate of iron green, and precipitated acetate of lead brownish yellow. It was of course not a true quinquina.

The orange-coloured quinquina of Santa Fé is cinnamon yellow. It is thick, very fibrous in its fracture. The thin pieces are rolled up, the others flat. It is not astringent. The cold infusion is scarcely coloured, and bitter. It precipitates tannin and emetic tartar white. It does not precipitate glue, nor infusion of q. of Loxa. It renders sulphate of iron slightly green. It ought not to be of much efficacy.

Common quinquina of Peru is gray externally, ochry red internally, its surface is rough, it is rolled up, bitter and astringent. Its cold infusion was slightly yellow. It precipitated emetic tartar, glue, and tannin in yellowish white, and sulphate of iron green. It reddened litmus paper. It appears to be the same as the gray quinquina called *superieure*.

Red quinquina of Santa Fé appeared to be the same with that above called simply quinquina of Santa Fé.

Yellow quinquina of Cuenca, from branches of four to six years old, but which appeared to be damaged, was gray externally, covered with a white lichen, and internally brown yellow. It had a fibrous fracture, scarcely any taste. The cold infusion was neither bitter nor astringent, and did not precipitate emetic tartar, glue, or tannin. It rendered sulphate of iron green, and precipitated acetate of lead. It ought not to be a febrifuge.

For the sake of comparison Mr. Vauquelin examined several substances analogous in some respects to quinquina.

The infusion of galls precipitated glue white, iron blue, emetic tartar yellowish white, infusion of yellow quinquina in dirty white flakes, copper brown yellow, and lead yellowish white. It does not precipitate infusion of quinquina of Santa Fé, or tannin.

The infusion of oak bark precipitates glue yellowish, iron blue, and copper brown. It does not affect infusion of quinquina of Sante Fé nor emetic tartar. It reddens tincture of litmus and is precipitated by oxalate of ammonia.

The bark of the cherry-tree is sometimes substituted for quinquina. Its infusion indeed precipitates sulphate of iron green, but it does not precipitate glue, emetic tartar, or tannin. Its febrifuge virtue is therefore doubtful.

Centaury and chamedrys give the same results as cherry-tree bark.

The infusion of the bark of the white willow precipitates glue, sulphate of iron green, and acetate of copper brownish, so that it should appear to be febrifuge.

The infusion of Angustura bark does not precipitate glue, but it precipitates infusion of galls, and that of yellow quinquina. It renders that of quinquina of Santa Fé only slightly turbid. It precipitates iron, emetic tartar, copper, lead, and infusion of tan, all yellow. It is not astringent, but extremely bitter, and may probably be a febrifuge.

The several kinds of quinquina which do not precipitate the infusion of tan nor emetic tartar, generally communicate to cold water a red colour, sometimes yellowish red, sometimes brown red. The infusion froths like wort by agitation. It is bitter and more or less astringent. It is soon covered with a green mouldiness. Some redden tincture of litmus. If twice as much alkohol is added, a grayish substance falls down which becomes black by drying; the liquor becomes clearer and redder. A small

quantity of pure alkali forms in the acid infusions a red precipitate passing into violet, a larger quantity redissolves the precipitate. On evaporation these infusions deposit by cooling a very bitter brown substance, soluble in alkohol, and precipitable from it by water: when thus separated it requires more water for its solution than when mixed with the other principles of quinquina. The whole of this substance is not separable from the infusion, by successive evaporations and cooling; but if the soft extract of these quinquinas is treated with alkohol, almost the whole of this substance is dissolved, and only a viscous brown substance is left perfectly soluble in water, not of a bitter taste, nor separable by evaporation and cooling.

This resinous substance is only partly soluble in cold water, reddish flakes being left; but by heat these also are taken up, and the liquor becomes of a clear deep red, but grows turbid on cooling, yet scarcely any thing is deposited. It is entirely soluble in a small quantity of water, an additional quantity renders the solution turbid, and a larger quantity renders it clear again.

The solution grows mouldy (which shews it is not a true resin), and exhibits the following effects with reagents. With ammonia it coagulates into a thick whitish matter, which grows brown and hardens in the air; but it softens again by heat, and becomes ductile and silky. With the alkaline carbonates it exhibits nearly the same effects. With the common acids it undergoes no change; the oxygenized muriatic acid renders it yellow, and if ammonia is then added, a grayish white, light, flaky precipitate falls down. It does not precipitate gelatine, although the infusions themselves do. The salts of iron render it deep green, and soon throw down a precipitate of the same colour. It does not precipitate emetic tartar. It renders tincture of litmus sensibly red.

This resinous substance seems to owe its solubility to the presence of the acid, and to retain some part of the alkalies employed to precipitate it. It performs sometimes the office of an acid and sometimes of an alkali. It is much more soluble in warm alkohol than in cold. The solution is brown red, extremely bitter, and is partly precipitated by water of a fine red colour. By spontaneous evaporation it crystallizes in needles.

That portion of quinquina which is insoluble in alkohol dissolves in water, and on being filtered and spontaneously evaporated in a warm place, crystallizes in plates. This salt may, by successive solutions and evaporations, be obtained pure and white. Its properties are related below.

After these kinds of quinquina have been almost entirely exhausted of their soluble parts by water and alkohol, the acids will take up the remaining portion of the resinous substance.

Nitric acid acquires a red colour, and takes some lime, which diminishes the acidity of the liquor. Saturated carbonate of pot-

ash occasions a fine red precipitate; but common carbonate throws down a violet, purple, or blue one. If the excess of the acid is got rid of, the metallic salts occasion abundant precipitates, and the liquor loses its colour. Muriate of tin throws down a rose-coloured precipitate, sulphate of iron a grayish, sulphate of copper a maroon, sulphate of titanium with a little carbonate of soda an orange of the same intensity as that produced by galls in the solutions of titanium. Alum by itself does not precipitate the nitric solution, but if a little alkali be added, a coloured lake falls down.

The effects of the sulphuric and muriatic acids upon the exhausted residuums of quinquina are similar to those of the nitric.

The resinous matter thus extracted from quinquina differs from common resins by its solubility in water, and its precipitation with the metallic salts; it may therefore be looked upon as a new principle, which renders the vegetables that contain it bitter. It seems to be of two kinds, one of which precipitates tannin and emetic tartar, and the other precipitates only glue.

It would appear that every febrifuge vegetable precipitates either tan, glue, or emetic tartar; and that they are more efficacious as they possess an union of these qualities. Although there are many vegetables that do not precipitate tannin, and yet are febrifuge, those that precipitate it are in general the best. The principle that precipitates tannin is brown, bitter, less soluble in water than in alkohol: it precipitates emetic tartar but not glue; it resembles the resins, but yields ammonia by distillation. The principle that precipitates glue is bitter and astringent; it is more soluble in water than the other; it is also soluble in alkohol, and does not precipitate emetic tartar.

As to the salt of quinquina mentioned above, it is white, and crystallizes in square or rhomboidal plates, the solid angles of which are sometimes truncated. It has no taste, and is flexible between the teeth. It requires five times its weight of water to dissolve it. It puffs up upon burning coals like tartar, and leaves a grayish mixture of charcoal and carbonate of lime. It does not alter the colour of litmus, and is absolutely insoluble in alkohol. It is decomposed by the fixed alkalies, and the subcarbonates of them, and then lime is separated. Ammonia does not decompose it. It is decomposed by the sulphuric and oxalic acids. It has no apparent effect upon acetate of lead or nitrate of silver. The concentrated sulphuric acid poured on the powder of this salt renders it black, but no sharp vapours are disengaged as from the acetates. The infusion of oak bark, and of some kinds of quinquina, for example, that of Santa Fé, occasion a yellow flaky precipitate in the solution of this salt.

This salt thus appearing to be formed of a vegetable acid and lime, the oxalic acid was employed to decompose it. A solution

of xalic acid was therefore poured gradually into a solution of 100 grains of the salt of quinquina, until it no longer produced any precipitation, 22 gr. of acid were used, and the precipitate when dry only weighed 27 : hence the salt contained 15 per cent. of lime, and the acid nearly half its weight of water of crystallization. The residual liquor was exposed to the air for several days, it became thick like a syrup, but did not crystallize until it was stirred, when it suddenly became a hard substance formed of plates diverging from different centres.

This substance was light brown, extremely acid, but a little bitter, as the salt was not very pure. It did not deliquesce, nor effloresce in the air. On a burning coal it melted very soon, boiled, became black, emitted sharp white vapours, and left only a very light coaly residue. It forms soluble and crystallizable salts with the alkalies and the earths. It does not precipitate the nitrates of silver, quicksilver, or lead. From these properties it may fairly be concluded that this substance is a new vegetable acid ; and accordingly Mr. Vauquelin calls it the kinic acid.

The physicians at Lyons, according to the information of Mr. Deschamps, attribute the febrifuge quality of quinquina to the salt of it ; and they assert that no intermittent fever can resist two doses of this salt, each dose being 36 grains, which indeed answer to at least 5 or 6 ounces of the raw drug. But this is doubtful, because it is difficult to judge from what cause the cure of a disease arises ; and the extract of quinquina prepared in the manner of Delagaraye, which contains this salt, has much less effect upon intermittent fevers than the raw drug from which it was prepared ; so also the tincture of quinquina which does not contain this salt, nevertheless cures intermittent fevers : to say nothing of those kinds of quinquina, or of other vegetables which have a febrifuge effect, although they do not contain this salt.

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*On sulphuretted Oxide of Tin, or mosaic Gold. By Mr.* Joseph Pelletier.—*Journ. de Phys. Juil.* 1806.

Proust found fault with Pelletier the elder, for saying that sulphuret of tin heated with cinnabar yielded mosaic gold along with quicksilver ; and he even affirmed that these bodies have no action upon each other.

Pelletier observed that the oxide of tin united with more sulphur than metallic tin, and brought forward this experiment in proof of it. The author, who is his son, has in his possession the very retort in which the distillation was made, and which contains the mosaic gold. To put an end however to all disputes, and to vindicate the accuracy of his father, he repeated the processes with the assistance of Mr. Lartiques, who had been the

elder Pelletier's pupil, at the time of the original experiments being made.

Six hundred grains of sulphuret of tin, and as much cinnabar, were pulverized separately; they had no smell before mixture, but afterwards they emitted that of sulphuretted hydrogen gas. On distillation by a well-managed fire, the mixture yielded sulphurous acid gas, two or three drops of water, nearly 3 gros (216 gr.) of quicksilver: some cinnabar was sublimed, and there remained in the bottom of the retort the sulphuret of tin covered with a very brilliant layer of mosaic gold.

When twice the quantity of materials was employed, and the fire more moderate, there was obtained sulphurous acid gas, water, quicksilver; and there remained a blackish matter, less compact than in the former process, but containing mosaic gold.

When the two substances were reduced to powder separately, and carefully dried before they were mixed together, they did not emit sulphuretted hydrogen gas: on distillation this time they yielded sulphurous acid gas, a little water, quicksilver, and a little cinnabar; in the bottom of the retort was a substance partly compact and partly in powder. This was accompanied with some mosaic gold, but not so visible as in the other trials; which might perhaps be owing to the manner of conducting the distillation, as it is on the conduct of the fire that the success of the operation depends.

It appears from these experiments that the oxidizement of the tin (in order to form mosaic gold) is owing in this case to the water contained in one or both of the materials, even after drying; the decomposition of the air in the retort may also have some share in it. Although the elder Pelletier was not justified in saying that the oxygen combined with the quicksilver in the cinnabar left that metal to unite with the tin; yet he was right in attributing the separation of the quicksilver to the oxidizement of the tin, which in this state is more attractive of sulphur, and decomposes the greater part of the cinnabar.

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*On the Use that may be made of Nitrate of Soda. By Mr.* Proust.—*Journ. de Phys. Juil.* 1806.

Five parts of this nitrate, one of charcoal, and one of sulphur, form a gunpowder that yields a very beautiful yellow flame, something reddish. The mixture being set on fire in a tube, burns exactly three times as long as the same charge of common gunpowder.

In this combustion the nitric acid is not so much decomposed as in that of nitrate of potash. Its gas is a mixture of carbonic acid, a little gaseous oxide of azote, and much nitrous gas.

The cheapest way of preparing the nitrate of soda, is to employ

that alkali instead of potash for the saturation of the mother water of the saltpetre-houses.

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*On the Birds Nests eaten in the East. By Mr.* PROUST.—*Journ. de Phys. Juil.* 1806.

THESE nests are in great request in China, as a luxury; yet, on examination, they were found to be only a single piece of uniform cartilaginous matter. On boiling one of them in water, it grew soft, and became similar to a sinew, without falling to pieces. It lost only 4 per cent. of its weight by this operation.

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*On some Species of Minerals. By Mr.* DELAMETHERIE.—*Journ. de Phys. Juil.* 1806.

WERNER has given the name of zoysite to a species of mineral found near Salsbourg by baron Zoys. A specimen of this mineral brought to Paris by Dr. Schneider is not crystallized: it has only prisms streaked longitudinally, sunk in a whitish and seemingly quartzose basis, which contains a little mica. These prisms cross each other confusedly, like those of some tremolites; and their edges are so rounded that their proper form is not determinable. On attempting to break off some of the prisms, rhomboidal fractures were discovered, but the angles were variable. All the characters of this fossil shew its affinity to the gray thallite of the Valais.

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The name of petrosilex has (in France) occasioned great confusion among mineralists, on account of its being applied to different species of minerals.

To attain some certainty, Mr. Delametherie desired Mr. Godon de St.-Memin to analyse the red petrosilex of Sahlberg in Sweden, this stone, which has a wax-like fracture, being regarded by all parties as a true petrosilex. It yielded 68 of silica, 19 of alumine, 1 of lime, 4 of oxide of iron, 5.5 of potash, 2.5 were lost in the process.

Saussure divided petrosilex into palaiopetre and neopetre; but the latter, which is found in secondary strata, is merely a silex. The former is found in primitive strata, and is the true petrosilex.

Werner and the German mineralists consider these stones as two distinct species, viz. hornstone and compact felspar.

Delametherie divides petrosilex into keratite (hornstone) and the proper petrosilex. The keratite contains more silica, and perhaps less potash, or even none; in its external characters it approaches towards quartz, and it is infusible. The true petrosilex

is nearly similar to felspar, and is fusible, but has not a lamellar fracture.

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The mountain of Ajou, situate in the community of Propieres, between Clayette and Beaujeu, in the department of the Rhone, is between 7000 and 8000 metres (yards) in height, and forms a part of the chain of the primitive mountains of the Cevennes. It is principally composed of granite, sienite, and porphyry. A vein of lead in granite with fluor and heavy spar is found on the side towards Propieres; veins of copper are found towards the Chateau de Chenelettes, and still lower, some veins of anthracite in porphyry. There is also primitive limestone not stratified, and the mountain contains a great quantity of primitive slates, of different kinds.

1. The corneus niger, solidus, durior, attactu lenis, nitens. Wall. Syst. Min. I. 371.

2. A riband slate with strata of different colours; it is gray-white with strata of ash colour, or light yellow. Some are light green. It is not so hard as the Siberian riband jasper, and breaks as usual in trapezoidal fragments.

3. The true trap or swartschjorl of the Swedes, which is the kieselschiefer of Werner. Cabal and Chevreuil, two pupils of Vauquelin, have analysed it, and found it to contain 55 of silica, 15 of alumine, 0.5 of lime, 10 of oxide of iron with some trace of oxide of manganese, 8 of potash, 5 of water and volatile matter, and 8 parts were lost, which included the carbone contained in the stone.

These primitive slates (lapides cornei Wall.) are frequently confounded (by the French mineralists) with the amygdaloid rocks; but Delametherie gives the name of tephrine to the basis of amygdaloid rocks, and thinks it proper to distinguish them.

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The differences observable between the aragonite and the common rhomboidal spar in hardness, specific gravity, phosphorescence, fracture, and crystallization, are so great that most mineralists make two species of these stones, notwithstanding the chemists cannot discover any difference in the proportion of their constituent parts. Mr. Delametherie endeavours to reconcile the two opinions. He thinks that although the molecules of the two substances are composed of the same chemical principles, they are, however, arranged in a different geometrical manner; and that, of course, the molecule has a different figure, and the other external characters also vary.

He regards it as a fundamental maxim in mineralogy, that the same chemical principles may, by the different geometrical positions in which they are placed, form dissimilar molecules. This appears from the differences already observed in other cases. Thus a black garnet and thumerstein afford, according to Vauque-

lin, nearly the same chemical elements. And therefore, in determining the species of minerals, it is necessary not only to have recourse to chemical analysis, but also to notice the whole of the external characters.

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*Observation.*—Hauy also, in a paper inserted in the Journal des Mines, No. 113, asserts the zoysite to be a variety of his epidote, which is synonimous to the thallite of Delametherie.

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*On certain Stones, and on volcanic Products. By* J. C. Delametherie.—*Journ. de Phys. Fev.-Mai* 1806.

In a connected view which this veteran naturalist gives of the analyses hitherto made of the various mineral bodies, he distinguishes the fusible stones called by the German mineralists compact felspar, klingstein, &c. by the generic name of petrosilicites; of which genus he enumerates the following species:

1. The proper petrosilex of the French mineralists, palaiopetre of Saussure, dichter feldspath of Werner, or the feldspath ceroide of Lucas.

2. Volcanic petrosilex, or klingstein.

3. Ophitine, the ophiobase of Saussure, the basis of ophite or green porphyry.

4. Leucostine, the basis of red porphyry.

5. Tephrine, the basis of amygdaloid. It is commonly ash gray, more or less deep: it has a dull earthy appearance: its specific gravity, so far as can be observed (considering the extraneous bodies mixed with it), is 2.7. It slightly scratches glass, but does not strike fire with steel. It is easily melted by the blow-pipe into a brownish green glass, more or less deep, and without bubbles. It does not affect any regular figure.

6. Varioline, the basis of the variolite of La Durance. Of this he is doubtful whether it be not the same as the ophitine.

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In a classification of the volcanic products hitherto observed, he refers them (according to the phenomena they exhibit) to certain stones from whence he thinks they were formed by fusion, subsequent cooling, and decomposition; instead of distinguishing them, according to their external characters, into lava, pumice, obsidian, pearlstone, &c.

1. Fontiform (or basaltic) lavas. They are usually blackish, unless they have been decomposed. They affect the magnetic needle. Their specific gravity is 3.0 or more. They contain from 14 to 25 per cent. of iron, and frequently sulphur. They melt by the blow-pipe into a black glass.

To this species belongs the black volcanic glass and basalt.

2. Petrosiliceous lavas. They melt by the blow-pipe into a colourless glass with bubbles. Their specific gravity is 2.34.

They contain a very small quantity of iron, and three fourths of their weight of silica. They frequently contain small insulated crystals of felspar.

To this species he refers the volcanic glass of Mexico, the pearlstone of Hungary and of Cinepecuaro, the lava of Gesenbach and of Puy Griou, the retinite of Planitz, the fossil farina of Santa Fiora, the variolite of La Loire, &c.

3. Tephrinic lavas. They are always less brilliant in their appearance than the last mentioned species. In the state of glass they strike fire with steel.

Cordier sent several specimens of this lava from Teneriffe.

4. Hornblendic lava. To which he refers the whinstone of the Scotch.

5. Leucitic lava. Of which only one variety has hitherto been found, viz. mica in a cement of leucite.

The three former of these species are subdivided into several varieties; as glass, scoria, pumice, porous lava, lapillo, volcanic ashes, porphyries with crystals of felspar, &c. decomposed lava, amygdaloid, variolite, and volcanic breccia. The fourth species is less often found.

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*Observations.*—We have only extracted such parts of these long papers as appear to be interesting.

The mathematical accuracy of Hauy has enabled him to reduce the species of crystallizable stones to their proper number, and to define them with accuracy, but the uncrystallizable stones are more untractable. With every respect for the abilities of Werner, we must still insist that the chemical habitudes of these stones afford a better basis for their classification than vague external characters; and therefore recommend the above distinctions to the attention of mineralists.

The tephrine of Delametherie is, we believe, the wacce of Werner.

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## *Analysis of a new Mineral found in Cornwall.* By Dr. J. Kidd. —*Phil. Journ.* No. 56.

This mineral was found in one of the Gwennap mines in Cornwall. It forms an incrustation round projecting particles of a spongy pyrites, mixed with quartz. The pyrites produced a deep blue colour when fused with borax.

Its colour varies from light ash to dark brown. Its fracture is like flint with sections of concentric layers: its texture is close, polished like that of a nut; its lustre is silky; its hardness is 8 of Kirwan's scale. In the mass it is not easily broken, but its fragments are very brittle. It yields a strong hepatic smell by trituration. Its specific gravity varies from 3.7 to 3.9.

It is soluble in nitric acid with violent effervescence, depositing

sulphur, and emitting sulphuretted hydrogen. It is soluble in muriatic acid with the same appearances. These solutions are precipitable by potash in a soft gelatinous form of a light cream colour, which changes to a pale olive green at 300° Fahr. The specific gravity of this precipitate is 4.5. The solution is also precipitable by prussiate of potash. This precipitate is light French gray.

By the heat of an Argand lamp it loses one per cent. of its weight. By a low red heat it loses 34 per cent. By a strong red heat in close vessels it is partly sublimed, and yields flowers of zinc. By the strongest heat of a moderate forge, it is sublimable in small prismatic crystals of a brown colour, appearing through a lens like brown semitransparent blende. These crystals are soluble in nitric and muriatic acids with the same phenomena as that blende.

This mineral being ignited in contact with platina, forms an alloy with it; the remaining platina was soft and brittle; it was also covered with an iridescent pellicle. The same effect was produced by galena when fused in a platina spoon.

On analysis, this mineral was found to contain 33 per cent. of sulphur, 66 of oxide of zinc, and a minute portion of iron.

As the usual mode of reducing oxide of zinc is very difficult, the power of the galvanic apparatus was ingeniously applied to effect this purpose. It is well known that metals may, by this means, be precipitated upon one another from their solutions in acids without any regard to their elective attractions. This mode however can scarcely be used as a means of analysis, as the precipitated metal is quickly redissolved by the acid from which it has been separated. But Klaproth has discovered that when the alkaline solutions of these oxides are used, the metals may be precipitated by each other in the order of their elective attractions. Accordingly the oxide of zinc was dissolved in a solution of potash. This solution being galvanized, deposited the zinc in a metallic state upon plates of iron, copper, and platina; and thus four fifths of metallic zinc were separated. If the communication with the galvanic apparatus was withdrawn before the zinc was taken out, it was speedily redissolved, by the potash from which it had been separated, by fresh potash, or even by subcarbonate of ammonia. The redissolution of the zinc by the potash appeared to be without effervescence; but, on closer inspection, minute air-bubbles were seen detaching themselves from the zinc.

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*Observation.*—The ore here described is probably the blättrige braune blende (foliated brown blende) of Werner, and may be considered as a very pure variety of that ore, in consequence of the small quantity of iron that it contains.

*On the Analysis of animal Fluids.* *By Dr.* JOHN BOSTOCK.—*Phil. Journ.* No. 56.

THE application of heat affords indeed an accurate test of the presence of albumen, but it is not possible by this means to separate it from the substance in which it is dissolved. The white of an egg diluted with half its weight of water was so coagulated by heat, that it might be cut by a knife; but if an equal weight of water was used, although the mixture was rendered completely opake by heat, it might be slowly poured from one vessel to another.

Notwithstanding the delicacy with which the oxymuriate of quicksilver detects albumen, the coagulation is so incomplete, that the filtered fluid is still opake, and coagulable by heat. But a perfect separation may be made by heating the fluid after the addition of the oxymuriate, which ought to be rather in excess. So far as could be ascertained, albumen in this precipitation unites itself with between $\frac{1}{3}$ and $\frac{1}{4}$ of its weight of the salt. The quantity therefore of albumen in any compound fluid may be estimated by employing a solution of the oxymuriate of a known strength, and observing what quantity is necessary to precipitate the fluid. Thus if 100 grains of a fluid require 60 grains of a solution containing $\frac{1}{20}$ of oxymuriate, it will follow that the albumen weighs $10\frac{1}{2}$ grains.

The uncoagulable part of the white of an egg is probably pure mucus. Diluted white of egg is more putrescible than when undiluted; mucus is far more subject to decomposition. Diluted white of egg when putrefied has the odour of pus, which is not the case with putrid mucus. Very little saline matter exists in the white of an egg; it seems to contain some muriate of soda, phosphate of lime, and about $\frac{1}{100}$ part of alkali, probably soda; but whether it is pure, or combined with carbonic acid, is uncertain.

Jelly it easily separated, and its proportion determined by considering that the compound formed by a solution of isinglass and a cold infusion of galls appears to consist of somewhat less than two parts of tannin to three of jelly.

No direct method has been discovered for determining the quantity of mucus in any animal fluid, on account of the muriate of soda, and other salts usually present, and which affect the reagents employed to detect it. An indirect method is to discover the quantity of albumen and jelly by the above methods, and then, by evaporating another portion of the fluid to dryness, to deduct their weight, from that of the whole solid matter left, and con-

sider the remainder as mucus, omitting any consideration of the salts.

Dr. Bostock has attempted to apply these methods to the examination of some animal fluids.

The fluid discharged by puncturing a tumour formed on the spine in the spina bifida was colourless, slightly opake, gelatinous, insipid, and its specific gravity scarcely differed from that of water.

2. It did not alter litmus, or an infusion of mallows.

3. One hundred grains by slow evaporation left 2.2 grains of solid matter.

4. In a boiling heat, its opacity was slightly increased, but it had no tendency to coagulation.

5. Oxymuriate of quicksilver produced at first but little effect; after some time an inconsiderable precipitate was thrown down.

6. Infusion of galls produced a slight precipitation.

7. Goulard produced a copious dense precipitation.

8. Nitro-muriate of tin rendered it more opake, and as if approaching to coagulation; after some time a precipitate was formed.

9. The residuum of No. 3 was partly soluble in boiling water.

10. The solution in No. 9 produced a copious precipitation with nitrate of silver.

11. It also formed a perceptible precipitate with oxalic acid.

12. And with infusion of galls.

13. A quantity of this solution No. 9 being evaporated slowly left cubical crystals of common salt in considerable quantity.

On these experiments Dr. B. observes, that from 3 we learn that 97.8 in 100 consist in water. From 4 and 5 it contains a little albumen. The quantity was too small to be weighed, but from appearances it could not be more than $\frac{1}{200}$ of its weight. From 5,6 and 12 it contains a minute quantity of jelly. From 7 and 8 it contains mucus. From 7, 8, 10, and 13, it contains muriate of soda, and from 11 a trace of lime.

By a similar investigation of the liquor pericardii, he finds it to contain 92 of water, 5.5 of albumen, about 2.0 of mucus, and about 0.5 of muriate of soda.

The saliva in its natural state contains very variable proportions of water, and it was found convenient to dilute it with more water in order to examine it with ease. As the diluted fluid was still opake, and had a flocculent matter suspended in it, and no effect was produced by exposing it to a boiling heat, the albumen it contained was insoluble in water, and in a state of coagulation. This was rendered further evident, by the albumen separating of itself when the diluted saliva was left at rest for a few days; as also by its being separable by filtration only. The saliva Dr. B. examined exhibited slight acid properties. If the estimate of Haller be admitted, that the saliva as discharged from the mouth

contains $\frac{4}{5}$ of water, the other constituent parts of saliva are 8 per cent. of coagulated albumen, 11 of mucus, and 1 of saline substances.

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*Analysis of a Substance called Turquoise. By Mr.* BOUILLON LAGRANGE.—*Ann. de Chim.* No. 176.

MINERALISTS have been much divided in the opinion they have formed of the substances called turquoises. Some have considered them as calcareous stones, or opake gems; others, on account of their blue or green colour, have classed them among the ores of copper; and others again have considered them as fossil bones coloured by the oxide of copper.

Chaptal says, they are fossil bones coloured by the oxide of copper. Those of the Lower Languedoc emit a fœtid odour when heated, and are decomposed by acids. The Persian turquoises yield no smell, and are not attackable by acids. Sage supposes, that in this latter kind, the boney part is become agathised.

The turquoise is not found in Turkey, but in Persia there are two mines of them; one of which is near Nichabourg, three days journey N. W. from Meched; the other is five days journey from thence: the latter are of a pale blue colour.

Lommer supposes the turquoise is a product of art; as he observed, that a fossil tooth found in Bohemia, on being exposed under a muffle to a violent heat, was converted into a similar substance.

It is said by Chardin to be extracted from Mount Caucasus, and by Bruckmann, to be found in Egypt, Arabia, and Samarkand. Dambry has brought them from Peru, some of which contain native silver. The occidental turquoise is found at Simore in the Lower Languedoc, Bohemia, Silesia, and Hungary.

Demetrius Agaphi, who visited the place where turquoise is found, near Chorasan, says, "That it occurs in kidney-shaped masses, and small sparks in a matrix; and that it ought to be looked on as a peculiar species of stone, which has the same geological situation as the opal, chrysoprase, and resiniform quartz." Lowitz found in it much alumine, a little copper and iron, but no lime or phosphoric acid.

Meuder affirms, that the oriental turquoise is found disseminated in a primitive argillaceous slate, of a blueish gray, or grayish black colour, along with black chalk, and quartz. Its colour is celadon apple-green, or grayish; when it begins to soften it is in a state of decomposition, and assumes a mountain-green colour; when decomposed it is yellowish white, greenish, and even straw yellow. It is commonly found disseminated in small superficial pieces, and

very rarely massive. Internally it is dull, or only glimmering. Its fracture is compact, the fragments are indeterminate, sharp edged, opake when decomposed, and more or less translucent on the edges. It is rather hard, passing into soft, according to the decomposition that has taken place in it. It is easily frangible. Its specific gravity is 2.500—2.800 according to Kirwan. When massive, it is sometimes mixed with copper tile ore. Meuder, therefore, thinks it ought to be placed between the opal and the chrysoprase.

Cuvier is of opinion, that the turquoises found near Simore, are the fossil teeth of an animal analogous to the mammoth, or carnivorous elephant, impregnated with copper.

The specific gravity of the turquoises examined by Mr. Lagrange, was 3.127. They were light green and blue. Their surface and fracture was smooth. They scratched glass slightly, and were difficult to pulverise. The powder was a greenish gray. By the blow-pipe they lost their colour, and became of a grayish white, but they did not melt. Heated in a platina crucible, they acquired the same colour, and became very friable; losing at the same time 6 per centum of their weight. They were soluble in the nitric and muriatic acids. On being analysed, they yielded 80 per cent. of phosphate of lime, 8 of carbonate of lime, 2 of phosphate of iron, 2 of phosphate of magnesia, some trace of phosphate of manganese, $1\frac{1}{2}$ of alumine; the remaining $6\frac{1}{2}$ being water, or else lost.

Several different turquoises exhibited the same principles, but Mr. L. could not be certain that any of them were from Persia.

Mr. Guyton also observed, that fossil bones exposed to heat became similar in colour to the turquoise; and that being digested in a weak ley of potash they turned blue; but on being exposed to the air they became white. Fourcroy and Vauquelin have also observed, that bones when strongly calcined assume a blueish tint, which they conjecture to arise from a mixture of phosphate of iron.

Vauquelin himself could not find any trace of copper in the turquoises analysed by Mr. L.; and the latter has found, that by pouring phosphate of soda, and some drops of muriate of iron ad maximum, into muriate of lime, a greenish blue phosphate of lime and iron may be obtained. A blueish green phosphate of iron may be obtained by decomposing phosphate of soda, by the muriate of iron ad maximum.

*On an Impurity in the Nitrate of Ammonia, which interferes with the Production of nitrous Oxide. By Mr.* JOHN SADLER.—*Phil. Journ.* No. 63.

IN attempting to procure nitrous oxide from the nitrate of ammonia, it frequently happened that a violent ebullition took place, and dense white fumes were disengaged so rapidly as to burst the retort. The residue in the retort scarcely ever exhibited the same phenomena upon being again subjected to the same treatment, but nitrous oxide was always produced without any further trouble.

The nitrate of ammonia was therefore examined, and it was found to contain a portion of muriate of ammonia. When the nitrate was perfectly freed from the muriatic acid by means of nitrate of silver, it yielded pure nitrous oxide, without any of the dense white vapour.

Pure nitrate of ammonia was prepared by the direct combination of the acid and alkali; and to a part of it a solution of muriate of ammonia was added. The pure nitrate on exposure to heat yielded, without any difficulty, one third more nitrous oxide than the other. The adulterated nitrate emitted very rapidly a dense opake elastic fluid, and afterwards the retort became clear, and only nitrous oxide was produced.

The dense gas thus obtained, remained opake after being passed through cold water. Paper tinged with litmus was rendered red by this gas. It is not inflammable, and a lighted taper is immediately extinguished by it. It has a disagreeable acidulous taste, and pungent smell, in which the peculiar odour of nitro-muriatic acid is perceptible. It is very slightly soluble in water.

The addition even of $\frac{1}{8}$ of muriate of ammonia to the nitrate is sufficient to produce these effects.

*Chemical Experiments on Guaiacum. By Mr.* WILLIAM BRANDE. —*Phil. Trans.* P. I. 1806.

GUAIACUM is green externally, transparent, and its fracture is vitreous. Its powder is gray, but becomes greenish by exposure to the air. When melted, it diffuses a pungent aromatic odour. The powder has a pleasant balsamic smell, but scarcely any taste, although when swallowed it excites a very powerful burning sensation in the throat. Its specific gravity is 1.2289.

Guaiacum is soluble in water; the solution is clear when filtered, and of a greenish brown colour. It leaves in evaporation a brown substance, soluble in alcohol, nearly soluble in boiling

water, and very little acted upon by sulphuric ether. 100 gr. of guaiacum yield 9 of this extractive principle. It appears to contain a minute portion of lime, for oxalate of ammonia being added to the aqueous solution of guaiacum rendered it turbid.

Alkohol dissolves guaiacum, and leaves only about 5 per cent. of residuum. The solution is of a deep brown colour. Water changes it to a milky fluid which passes the filter. Muriatic acid, oxygenized muriatic acid in a liquid form, and sulphuric acid, precipitate the resin. Acetous acid does not produce any precipitation. Nitric acid, diluted with $\frac{1}{4}$ water, causes no precipitate until some hours have expired; the liquid becomes first green, then blue (in both which states a similarly coloured precipitate is thrown down by water), and afterwards brown; when a brown precipitate is spontaneously separated. These changes of colour, and the very beautiful pale blue colour of the precipitate formed by oxygenized muriatic acid, are owing, in Mr. B.'s opinion, to the absorption of oxygen. He found that guaiacum itself, by exposure to oxygenized muriatic acid gas, became green, blue, and at length brown: the presence of light was not necessary for this change to take place. Alkalies do not precipitate the solution of guaiacum in alkohol.

Guaiacum is less soluble in sulphuric ether than in alkohol; the properties of this solution are nearly similar to those of the solution in alkohol.

Muriatic acid dissolves only a small portion of guaiacum; the solution is deep brown.

Sulphuric acid forms with guaiacum a deep red solution, which is precipitable when fresh by water, or by the alkalies. The precipitate by water is lilac-coloured. By heat the resin is decomposed; and there remains, at last, a coaly residuum with some sulphate of lime.

Nitric acid, of the spec. grav. of 1.39, dissolves guaiacum with great facility: much nitrous gas is emitted. The fresh solution yields a brown precipitate with the alkalies; which is redissolved by the application of heat. Muriatic acid separates the guaiacum, but somewhat changed; sulphuric acid, however, did not occasion any precipitation. This nitric solution deposits by rest, in the course of some hours, crystallized oxalic acid.

Dilute nitric acid dissolved, with effervescence, part of this resin; the remainder is converted into a brown substance, similar to the precipitate from the solution in alkohol. This brown substance may also be obtained by carefully and slowly evaporating the recent nitric solution to dryness. It is equally soluble in alkohol and sulphuric ether: it is insoluble in water. When burned it emits a peculiar smell, more resembling an animal than a vegetable body. By repeated abstractions of nitric acid, or by the use of a large proportion of it, the product is equally soluble

in water and alkohol, and forms a solution which has an astringent bitter taste.

Guaiacum is soluble in the pure and carbonated alkalies: the solutions are greenish brown. Nitric acid precipitates these solutions of a deep brown colour; the precipitate is similar to that formed by this acid from the solution in alkohol. Dilute sulphuric acid, and muriatic acid, form, in these alkaline solutions, flesh-coloured precipitates; which differ from guaiacum, in being less acted upon by sulphuric ether, and more soluble in boiling water. When these precipitates were dissolved in ammonia, and again precipitated by muriatic acid, they were still more approximated to the nature of extract.

One hundred grains of guaiacum yielded on distillation, 5.5 of acidulated water, 24.5 of thick brown oil, which became turbid on cooling, 30.0 of thin empyreumatic oil, 9.0 of aeriform fluids, chiefly carbonic acid, and carburetted hydrogen, 30.5 of coal was left in the retort. This coal left on incineration 9 grains of lime. No traces of any fixed alkali could be discovered.

From these experiments, it is evident that guaiacum is a substance very different from those which are denominated resins, balsams, gum-resins, gums, or extracts; and that it may, perhaps, be properly denominated an extracto-resin.

The action of oxygen on some of the other resinous bodies is remarkable. It is well known, that on digesting mastich in alkohol, only a part of it is dissolved; as there remains an elastic substance, which appears to differ from caoutchouc by becoming hard when dried by exposure to air. Water precipitates the part which is dissolved in the state of a pure resin: but when a stream of oxygenized muriatic acid gas was passed through the solution, a tough elastic precipitate was formed, which became brittle when dried, and was soluble in boiling alkohol, but separated again as the solution cooled.

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*Analysis of Rocksoap. By* Bucholz.—*From Gehlen's Journ. der Chem. in Ann. de Chim.* No. 167.

A specimen of this mineral from Artern, in Upper Saxony, yielded on analysis, 44 silica, 26.5 alumine, 8 oxide of iron, 20.5 water, 0.5 lime, and a loss of 0.5 was sustained.

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*On Berzelius's Discoveries as to the sebacic Acid. By Mr.* Hisinger.—*Ann. de Chim.* No. 172.

Berzelius has discovered, that the sebacic acid of Thenard bears the same relation to the benzoic acid, as the zoonic acid of Berthollet or the lactic acid of Scheele bears to the acetous acid.

In beef marrow this acid is not pure, but it is combined with a particular animal matter, which forms a triple combination with the acid, and the oxides of silver, quicksilver, or lead. In other respects, the sebacic acid acts like the precipitated benzoic acid, but not like the sublimed. The acid yielded by tallow and fat, precipitates the above three oxides; but the acid of marrow does not produce any precipitation unless it is combined with alkali. The sublimed benzoic acid, or the salts formed of that pure acid, do not decompose the solutions of these oxides, unless they are concentrated. The benzoates are equally proper as the succinates, for the separation of iron and manganese, under the same circumstances.

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*On the Proportion of the Principles in sulphuric Acid. By Prof.* Klaproth.—*Ann. de Chim.* No. 173.

Mr. K. first gives the various determinations of former chemists, of the proportions in which the elements of sulphuric acid and of sulphate of barytes are combined together: he then relates his own experiments: viz. 151 grains of sulphur were converted into acid by means of nitric acid; on this acid being added to muriate of barytes, 1109 grains of sulphate of barytes were formed, which by calcination were reduced to 1082 grains. In the second experiment, 100 gr. of sulphuric acid, whose specific gravity was 1.850, being diluted with water, and then added to muriate of barytes, produced 225 grains of well-dried sulphate.

From these experiments it follows, that sulphuric acid, of the specific gravity of 1.850, contains 74.04 concrete acid, and 25.06 water; or otherwise, 31.05 sulphur, 42.09 oxygen, and 25.06 water: that concrete sulphuric acid contains 42.03 sulphur and 57.07 oxygen; and that sulphate of barytes contains 67 barytes, 14 sulphur, and 19 oxygen.

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*On the Effect of the Ammonia-muriate of Platina on the human Body.—Phil. Journ.* No. 62.

The precipitate of platina, by muriate of ammonia, or the ammonia-muriate of platina, has a peculiar effect upon this anonymous writer; and which is, perhaps, like the fit of asthma produced by the powder of ipecacuanha, peculiar to certain constitutions only.

Every time the paper containing the precipitate was opened, even when it was not touched, but merely inspected for a minute or two, a catarrhous defluxion was immediately brought on, with heat and redness of the face, as from erythema, and a shortness of the breath. The catarrhal symptoms continued for about an

hour; but the dyspnœa lasted longer: a slight disagreeable taste was at one time felt. The same symptoms were also produced, when after having left the laboratory for about two hours, the relator returned to the same place, although the paper was not reopened. Wetting the face with cold water was very serviceable in removing the erythema.

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*On a meteoric Stone which fell near Valence. By Messrs.* MONGE, FOURCROY, BERTHOLLET, *and* VAUQUELIN.—*Ann. de Chim.* No. 175.

A GREAT noise was heard at Valence, on the 15th of March 1806, at five in the evening. This noise resembled the report of a cannon, and was preceded by a dreadful roll of thunder. Immediately a mass of about four pound weight fell down, which broke the branch of a fig-tree, and made a dint in the ground about 3 inches deep. The thunder came from the south, and went towards the north. The sun was not hid by any cloud, although there were some in the sky. It was on the same day that another stone fell at St. Etienne.

The stone that fell at Valence was black, very friable, and marked paper like plumbago. It acquired a bituminous polish by rubbing. In the mortar it became flattened, and divided into small flakes, instead of being pulverized. By heat it emitted a slight odour of bitumen. Its specific gravity was 1.94.

Five grammes (77 gr.) of the stone was treated with twice as much nitrate of potash; a slight deflagration took place. The vapours being received in lime water, precipitated 15 decigr. ($18\frac{1}{2}$ gr.) of carbonate of lime. By elixiviating the residuum, chrome was obtained.

After the chrome, carbone and silica were separated. The iron was precipitated, from a very acid muriatic solution of the residuum, by ammonia. The iron drew down with it six decigr. (9 gr.) of magnesia, although magnesia is not precipitable by ammonia, from a solution with excess of acid.

The remaining liquor required a very large quantity of potash to throw down the remainder of the magnesia; because magnesia is not separable from triple salts until the ammoniacal salt is entirely decomposed. The magnesia thus obtained, was rendered green by the oxide of nickel, which was precipitated along with it; for although there was far more ammonia than was necessary to dissolve the nickel, yet none was retained: so powerful was the attraction between the magnesia and the oxide of nickel.

It was also remarked, that when a solution of iron holding manganese, was precipitated by ammonia, some of the manganese remained in the fluid, although it contained an excess of alkali; so that when the excess of the ammonia was got rid of,

by means of an acid, the solution yielded a white or rose-coloured precipitate, by means of the prussiate of potash: a circumstance which shews the formation of a triple compound of acid, ammonia, and manganese.

The stone which fell in the environs of Valence is composed of 38 per cent. of oxide of iron ad minimum, 30 of silica, 14 of manganese, about 2 of nickel, about 2 of manganese, about 2 of chrome, $2\frac{1}{2}$ of carbone, and an unappreciable quantity of sulphur. The remaining $9\frac{1}{2}$ per cent. was lost, but it may be attributed in great measure to water.

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*Analysis of a meteoric Stone which fell in the Arrondissement d'Alais, on the 15th of March* 1806. *By M.* THENARD.—*Ann. de Chim.* No. 175.

WE gave in our last number an account, by Messrs. Dhombres, firmas and Pages, of the fall of this stone.

It differs much in appearance from the other stones which have fallen on the earth; and has greatly the appearance of a piece of sea-coal. It is black, and formed of laminæ, which are only slightly adherent to each other, and are in themselves very friable. It leaves upon paper traces like those of black lead. Its specific gravity is 1.94.

Several small grains of this stone were attractable by the loadstone. When calcined in contact with air, it became red, and lost scarcely any thing of its weight. When heated in a retort, it remained black, lost seventeen per cent. of its weight, and gave out some carbonic acid gas. When melted with borax, it yielded a yellowish green glass.

On analysis, this stone appeared to contain 21 per cent. of silica, 40 of black oxide of iron, $2\frac{1}{2}$ of oxide of nickel, 2 of oxide of manganese, $2\frac{1}{2}$ of carbone, 9 of magnesia, $3\frac{1}{2}$ of sulphur, 1 of chrome, and $18\frac{1}{2}$ were lost, of which part was water: so that it was very similar in its composition to the other stones which have fallen. It has less silica, and more oxide of iron, but like them it contains neither lime nor alumine. But it differs from them in containing a little carbone, and having the metals in the state of oxide. This difference would lead us to suppose, that it had not undergone the action of any great degree of heat, which would have burnt the carbone, and reduced the metals. To this we may add, that when treated with acids, it is not converted into a gelatinous mass; whereas the other stones constantly form such a product, a fact that indicates their having sustained a commencement of fusion.

*On Roman Alum, compared with the Kinds manufactured in France. By Messrs.* THENARD *and* ROARD.—*Ann. de Chim.* No. 175.

THE great reputation which the Roman alum bears among manufacturers and dyers, being disadvantageous to the sale of the French, the authors were engaged to examine whether this predilection was well founded, and if so, in what manner the French alum could be improved, so as to enter into competition with it.

They found that the French alum contained exactly the same quantity of the constituent principles of alum, viz. 26.04 per cent. of sulphuric acid, 12.53 of alumine, 10.02 of potash, and 51.41 of water; although they exhibit sensible differences both to reagents, and in the processes of the dyers.

These differences arise from the unequal quantity of iron which they accidentally contain, for they disappear when the alums are purified, and are reproduced when the sulphate of iron is again united with them.

Roman alum contains only $\frac{1}{2000}$ of sulphate of iron; that of Liege contains at most $\frac{1}{1000}$, that of Javelle somewhat less; those of Bouvier and Curaudau $\frac{1}{1600}$ or $\frac{1}{1700}$. The effects of the latter proportion can only be discerned by regeants, and its effects upon silk dyed with dyers' weed or cochineal. Prussiate of iron immediately affects those of Javelle and Liege.

Roman alum is not absolutely necessary in dying, for colours equally good may be obtained from the alum of Liege purified by solution in hot water, and washing the pulverulent crystals with cold water, by which means all the sulphate of iron may be separated.

The alum of Bouvier and of Curaudau yields colours which can only be distinguished from those of Roman alum by experienced persons. Although the alum of Javelle and Liege contain only $\frac{1}{1000}$ of sulphate of iron, they yield less brilliant colours than the purer alums.

This effect of sulphate of iron is not the same upon different materials, and with different dye-stuffs. It is very sensible in silk dyed with dyers weed and cochineal; it is somewhat less upon cotton, and much less upon woollen goods dyed with the same colouring matters.

Wool appears to retain a much less quantity of sulphate of iron than cotton, and that less than silk; for the colours on wool are less altered by $\frac{1}{2^{\frac{1}{2}}}$ of the sulphate than those on silk are by $\frac{1}{100}$. In the colours afforded by madder, archil, and kermes, it requires a large proportion of sulphate to alter the colour for the worse.

It is certain therefore that the manufacturers of alum may, by very simple means, and without much expense, render their article fully equal to the Roman.

*On Ultramarine. By Messrs.* Desormes *and* Clement.—*Ann. de Chim.* No. 171.

The lapis lazuli may be considered as the ore of ultramarine. To extract that colour, a very peculiar process is used, which has no analogy with any other manipulation in the arts. The lapis lazuli is levigated, and then well mixed with a melted composition of resin, wax, and linseed-oil. The compound being then cooled, is ground with a pestle or a roller in warm water. This water becomes turbid, and is rejected. Fresh water is then added, which becomes loaded with the colouring matter, and being poured off deposits the ultramarine. This is repeated till the water acquires only a dirty gray hue. Only two or three per cent. of beautiful ultramarine could be obtained from a very fine lapis lazuli.

The specific gravity of the most beautiful ultramarine is 2.360. It contains oily or resinous particles decomposable by fire; by ignition this is burned away, but the colour is only slightly deteriorated, and requires levigation to reduce it to its former fineness.

By a violent heat, ultramarine melts; and if the resinous matter is not entirely burnt away, it forms a black enamel; but if this has been done, it forms a transparent and almost colourless glass, and loses $\frac{1}{12}$ of its weight. It forms a transparent glass with borax; at the same time sulphur and carbonic acid are both given out.

The oxygenizing end of a Voltaic pile deprives it of colour, but the other end has no apparent effect upon it. Exposed to a red heat in contact with oxygen, its weight is augmented one per cent. and it acquires a dirty green colour. Hydrogen in the same circumstances turns it red, and takes sulphur from it. No water appears to be formed, but a loss of weight is observed. Sulphur melted with and volatilized from ultramarine does not alter it. Neither liquid sulphuretted hydrogen nor lime-water have any action upon it. Barytic water, by the help of heat, deprives it of colour, and takes up silica and alumine.

The sulphuric, nitric, muriatic, and oxygenized muriatic acids, deprive ultramarine of its colour. The three first acids form a gelatinous mass with it; the fourth dissolves it almost entirely. Sulphuretted hydrogen is evolved by the dilute sulphuric and muriatic acid. Nitric acid produces nitrous gas and sulphuric acid. Acetous acid acts upon it, but in a weaker degree. Potash and soda boiled upon ultramarine do not alter its colour, but they diminish its weight, and take alumine from it. Potash by fusion with ultramarine forms a reddish mass, which exhibits the same phenomena as if it were a stone composed of silica and alumine. Ammonia has no action upon ultramarine. If this be heated

with oil, and afterwards washed with an alkaline ley, the weight is diminished.

Great difficulty was experienced in attempting to analyse ultramarine, but by allotting a separate portion of it for the investigation of each of its constituents, it was found to contain 35.8 per cent. of silica, 34.8 of alumine, 23.2 of soda, 3.1 of sulphur, and as much carbonated lime. The latter was not essential to its composition. A loss of at least five per cent. was always experienced, and a suspicion was excited that the silica was united with some other principle, although it could not be discovered.

The cement mixed with the lapis lazuli imparting oil to the ultramarine forms with it a kind of soap, which rendering it a little soluble in water, it is carried off, while the veinstone remains behind in the cement, on account of its not being so easily wetted as the ultramarine. So that the process for extracting the ultramarine is a true washing, taking that word in its usual domestic sense.

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*On the chemical Properties of Oisanite compared with those of Titanium. By Mr.* Vauquelin.—*Journ. des Mines,* No. 114.

Mr. Vauquelin had long been of opinion that an analogy subsisted between oisanite (anatase of Hauy) and titanium; but the want of a sufficient quantity to push his inquiries to the required extent left him in an uncertainty. By making an excursion to Oisan he at length procured as much as sufficed for his experiments.

The difference of form and specific gravity he attributed at first to the degree of oxidizement; but by heating them in the same fire neither altered their weight, only the titanium became redder, in consequence of the iron which it contains.

Both titanium and oisanite are affected in the same manner by alkalies; they combine with them, swell, become white, and are rendered partly soluble in water. A true combination takes place, which even dissolves in the acids, and forms triple salts. These salts are easily decomposed by a slight heat.

Titanium and oisanite were separately dissolved in muriatic acid. Both the solutions were precipitated of a fine blood-red by infusion of galls; but that of oisanite yielded a yellowish brown precipitate with prussiate of potash, whereas the solution of titanium yielded a very deep green one. That this was owing to iron, appeared evident from the addition of a few drops of muriate of iron, which occasioned the precipitation of a similar green prussiate.

The solution of titanium was evaporated to dryness, and the residuum was elixiviated by water; a yellow liquor was obtained, and a white substance left which was insoluble in water or the

acids; but this substance being again melted with potash, and treated with water to take away the excess of the alkali, dissolved in acids. The yellow liquor first obtained precipitated prussiate of potash blueish green; but the solution of the white matter treated with potash, on the other hand precipitated the prussiate of a yellowish brown, like oisanite.

Hence Mr. Vauquelin concludes, that the difference between oisanite and titanium consists in a small quantity of iron and manganese contained in the latter. The quantity, however, is so small that he cannot think it to be the cause of the crystalline forms which distinguish the former.

Oisanite therefore must be now considered as the first species in the genus titanium.

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*On the Smelting of sparry Iron Ores. By Mr.* Hassenfratz.—*Journ. des Mines*, No. 114.

The furnace of Saint Helene being the nearest to the Mining-School at Paris, furnished the specimens examined. The analyses were made by Mr. Berthier.

The roasted ore made use of in that furnace contains 16 per cent. of silica, only 1 of lime, 1.56 of metallic manganese, 37.30 of metallic iron, and 23.44 of oxygen and water.

The scoriæ were examined in three different states; first, when the furnace was in good working order; secondly, when it began to be deranged; and lastly, when it was in bad order. The proportions of the manganese in these scoriæ are 12.5, 10.64, and 5.80; the proportions of iron are, 0.5, 4.68, 4.7: and the last kind of scoriæ contains, besides the iron combined with it, no less than 60 per cent. mixed with it; the two former scoriæ have none of this mixed with them. The proportion of silica in the two former is 56, and in the latter 70. That of lime in the two former is 18, in the latter 6.

It is a remarkable circumstance that the proportion of magnanese in the scoriæ increases in proportion to the heat of the furnace; and that the proportion of iron in them follows a contrary ratio. And he also found that the quantity of iron obtained in the analysis of ores (whether it is performed by the moist or the dry way) much exceeds that which can be obtained in the great operations, even as far as 20 per cent. when the iron in the scoriæ is taken into the computation.

It is not sufficient to analyse the specimens chosen out for a cabinet to give us the necessary information in metallurgy. The minerals employed in the smelting works must be examined after they have undergone the usual preliminary preparations. To this investigation ought to be added the examination of all the products obtained, and then by the comparison of these results, a theory may be established to guide the operator in his future labours.

*On Coffee. By* M. Paysse.—*Ann. de Chim.* No. 176.

Mr. Parmentier having written to Mr. Paysse for information on the subject of coffee, was favoured by him with a long detail concerning it. Some parts of this he now lays before the public, from which he concludes,

That coffee contains a peculiar acid, which is in an uncombined state, as the powder of this seed immediately reddens blue vegetable colours. This acid may be separated either by a cold infusion, or even by alkohol.

The acid decoction of coffee speedily decomposes the greater part of metallic solutions, and particularly those of tin, lead, iron, &c.; the precipitates thus obtained are, at the same time, more abundant in quantity and darker in colour than those formed by the pure acid. This difference arises from the decoction containing also extractive matter, colouring matter, albumen, &c.; so that the colouring matter unites with the precipitate formed by the coffic acid with the oxide, and the albumen being at the same time separated from the acid which retained it in solution, falls down and augments the quantity of the precipitate. In fact, if the coffate of tin, of lead, or of alumine, is boiled in the coloured decoction of any vegetable substance, a lake will be obtained.

The coffic acid may be obtained pure by mixing the decoction of coffee, or its tincture, with the muriates of tin or of lead; and by a subsequent decomposition of the precipitates by means of sulphuretted hydrogen, according to the process of Chenevix, or by decomposing the coffate of lead by sulphuric acid.

This new acid is not crystallizable, but it is soluble both in water and alkohol.

Coffic acid forms a green precipitate with the prussiate of iron contained in the common prussiate of potash; and is thus of great use in chemistry, in order to obtain a pure prussiate of potash, which until now could never be obtained without the concourse of iron.

With the oxygenized sulphate of iron, coffic acid produces a fine green colour; at the end of six hours, a precipitate of the same colour was separated. The green sulphate of iron became very slightly green; but after being exposed for some time to the air, it grew darker.

Gelatine was not precipitated by the coffic acid; the muriates of lead and of tin were quickly and copiously precipitated of a grayish white; the muriate of antimony, very quickly in white flakes; the nitrates of bismuth and of quicksilver, dirty white; the nitrate and the acetate of copper, dingy brown; the nitrate of silver, and of cobalt, and the sulphates of manganese and of zinc,

were not altered; the sulphate of copper merely lost its colour; the nitro-muriates of gold and of platina did not even change their colour.

The sulphuric acid heated with the coffic became highly coloured, and emitted vapours of sulphurous acid; the nitric acid was decomposed, and malic acid was produced; the oxygenized muriatic acid had a similar effect.

Potash, soda, or ammonia, only produced deep yellow mixtures drawing towards orange colour; lime, barytes, strontian, and the hydro-sulphurets, afforded phenomena very similar to those of the alkalies; prussiate of ammonia also yielded a similar result; the sulphate of alumine, the acetate and the nitrates of barytes, were partly precipitated in a white powder. Tannin and tincture of galls were sensibly discoloured by the coffic acid.

The precipitate obtained from sulphate of iron by means of coffic acid is soluble in the nitric, sulphuric, phosphoric, and oxalic acid; but the other acids do not act upon it.

As to the attractions of the coffic acid, it combines the strongest with the metallic oxides. The oxides of tin, lead, quicksilver, iron, antimony, bismuth, and copper, when precipitated from their solutions, and heated with this acid, unite into it, and form saline combinations, generally of an austere metallic taste, not crystallizable, pulverulent, and scarcely soluble in water. That with quicksilver is nevertheless soluble in 160 times its weight of water. These metallic salts combine with several colouring substances, and precipitate along with them in a fixed state, particularly when the coffates of tin, lead, antimony, and alumine, are boiled with the stuffs to be dyed; which stuffs are afterwards to be dried, and then dyed. This new mode of preparing stuffs for dyeing is particularly useful when saffron, yellow wood, madder, archil, and some pharmaceutical extracts are employed as colouring materials. All these coffates are decomposable by fire, and still more easily by the sulphuric acid, except those of iron, tin, and antimony. Nitric acid decomposes only the coffate of copper.

The coffic acid unites the easiest with alumine; the salt is but slightly soluble in water; it has a slight saccharine and astringent taste; it is always pulverulent, and fixes certain colours. Lime, barytes, strontian, and magnesia, combine with it; the latter adheres to it very feebly.

Potash, soda, and ammonia, form very soluble combinations of a bitter taste scarcely crystallizable, decomposable by a slight heat. They are all of them yellow, but become brown if too much heated.

Muriate of tin and of lead readily decomposes these salts, as also the sulphuric acid, which however does not act upon the coffate of alumine. The nitric, muriatic, and phosphoric acids, also decompose the greater part of them. In using the nitric

acid, it sometimes happens that the coffic acid itself is changed into the malic, so that there are obtained both a nitrate and a malate.

This coffic acid, of course, exhibits properties very different from gallic acid, or from tannin.

The principle considered by Mr. Chenevix as tannin, is, without doubt, the acid now described; although that chemist did not sufficiently examine it. He asserts the decoction of roasted coffee to precipitate gelatine; but after having examined the infusions and decoctions of various kinds of coffee roasted, no trace of tannin could be discovered in them.

The coffic acid by destructive distillation affords much carbone, and but little hydrogen or oxygen.

The carbonaceous residuum of coffee being reduced to ashes yields muriate of potash, lime, and a very minute proportion of iron.

100 parts of the extract of coffee made by water from 750 parts of coffee yielded 55 of coffic acid, 25 of extractive matter, 5 of vegetable albumen, 9 of resinous matter, and 6 parts were lost.

The different kinds of coffee contain the coffic acid in nearly the same proportion. It is found also unaltered, but in less quantity, in the infusions and decoctions of roasted coffee, and also in the products of the distillation of coffee.

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*On Coffee. By* C. L. Cadet.—*Journ. de Chim.* No. 174.

Boiling water poured upon raw coffee, as brought to Europe, becomes yellowish green; but when the coffee is newly gathered the infusion is of a fine emerald colour, and is used to colour maps. By continuing the boiling the decoction turns brown, and a slight scum is separated; it passes clear through the filter, but becomes turbid on cooling. Potash renders it browner; ammonia has the same effect. Lime-water produces an abundant flaky precipitate. Sulphate of iron changes it into black ink. It does not render solution of isinglass turbid. Oxygenized muriatic acid only partially discolours this decoction; and if an alkali is then added, the liquor becomes red.

Eight pounds of water distilled upon one pound of raw coffee acquired a very aromatic odour, and some drops of concrete oil resembling that of the myrica cerifera swam upon it. The decoction remaining in the still was viscous; when this was diluted with some more water, alkohol flung down an abundant precipitate, resoluble in water, and appearing to be mucilage. The residual coffee being dried, and digested in alkohol, yielded a tincture which was precipitated by water.

The decoction of raw coffee does not change blue vegetable

colours red, as is asserted by the chemists, and particularly by Geoffroy, who even says, that water distilled in a water-bath upon coffee becomes very acid. On the contrary, the decoction renders litmus green. It decomposes sulphate of alumine, and forms a lake of a pale colour.

Alkohol, even in the cold, extracts from raw coffee a large proportion of an extracto-resinous substance, which is precipitated by water of a dirty white colour. The tincture is also precipitated by sulphate of iron, green; and by [oxygenized] muriatic acid, reddish brown. The residual coffee, after being dried, yielded, when treated with water, extractive matter and mucilage.

Mr. C. thinks, that although the proportions of the principles pointed out by the experiments vary according to the ripeness of the grain; yet that, from what he has experienced, we may consider upon a mean, eight ounces of raw coffee to contain 1 oz. of mucilage, 1 drachm of resin, the same quantity of colouring extractive matter, $3\frac{1}{2}$ dr. of gallic acid, 5 oz. $3\frac{1}{2}$ dr. of parenchyma, and 10 grains of vegetable albumen.

It has been long known that coffee will sprout in boiling water, but it will not sprout in boiling alkohol, either for want of sufficient heat, or because alkohol destroys the germinative faculty.

Mocha coffee differs essentially from Martinique and Isle of Bourbon coffee, as it contains less gum and gallic acid, but more resin and aroma.

We may distinguish three distinct periods when coffee is roasted; 1. when the grain loses its natural colour, and assumes that of dry almonds, or raspings of bread; 2. when the coffee becomes reddish brown; and, 3. when it becomes almost black, without however being carbonized.

Two ounces of Martinique coffee were roasted light brown; it lost two drachms: it was difficult to grind. The cold infusion of it contained tannin, and precipitated gelatine. Its taste was very aromatic; it had the flavour of almonds, without any bitterness, and smelt green. By a hot infusion it retained the same aromatic taste, but its green smell was less sensible.

Two ounces more were roasted reddish brown; they lost three drachms, and the coffee was more easy to grind. By infusion in cold water it yielded less tannin. Its aromatic flavour was less sensible, its taste more approaching to that of burnt sugar; it had neither bitterness nor greenness. The infusion in hot water had no more taste nor scent.

Two other ounces were roasted black; they lost three drachms and forty-eight grains. This coffee was easily pulverized. The infusion in cold water had scarcely any scent. Its flavour was burnt and slightly bitter. It yielded a precipitate with gelatine; but this effect was scarcely perceptible. The infusion in hot water was more bitter, more empyreumatic, and had a more distinct scent.

All these infusions contained mucilage and gallic acid, which augmented in proportion as the torrefaction was more advanced, while at the same time the tannin was diminished. Mr. Bouillon Lagrange considers gallic acid as a modification of tannin; and these experiments seem to countenance his opinion.

The cold infusion of roasted coffee, when filtered, was a fine clear brown. It did not redden litmus paper. It became black with sulphate of iron, and slightly precipitated gelatine. Alkohol separated a little gum, and the mixture acquired the smell of juniper.

Roasted coffee infused for a quarter of an hour in water at 70° yielded an infusion that did not redden turnsol, nor precipitate gelatine, but which formed ink with sulphate of iron. Alkohol separated some gum from this infusion.

Roasted coffee boiled for two hours in water yielded a decoction whose odour was less agreeable and less aromatic that that of the infusion. It did not change the colour of blue paper, nor precipitate gelatine; but it became black with sulphate of iron. Alkohol separated more gum from it than from the infusions.

No difference was observed between Martinique, Mocha, or Isle of Bourbon, coffee in the above experiments.

The clear and filtered decoction of [roasted] coffee boiled for some time in contact with the air becomes turbid, and lets fall a black powder, which has been taken for a resin, but which is oxygenized extractive matter.

Decoction of [roasted] coffee filtered and evaporated to an extract has no longer any aromatic scent. It is bitter, and on being treated with warm alkohol the colouring extractive matter is taken up, but the tincture is not precipitated by water.

Roasted coffee digested with alkohol yields a high-coloured tincture, from which water precipitates a much greater quantity of resin than from the tincture of raw coffee. This resin in raw coffee is white, in roasted coffee reddish brown.

It is very singular that the tannin of roasted coffee is only taken up by cold water.

Water distilled off roasted coffee takes up the aroma, and carries over some drops of a solid essential oil; but the distilled water, when tried with reagents, does not appear to hold any thing in solution.

Two ounces of [roasted] coffee placed in a filter were washed with cold water till the liquor that passed no longer indicated, by reagents, that any thing was taken up. It required 68 ounces of water, and every four ounces that passed was examined separately. All of them contained gallic acid in proportion to their order; the four first contained gum; and it was only the first that precipitated a solution of glue.

The coffee thus washed was dried in a stove, and then infused in water at 75°. The scent of this infusion was agreeable, but

weaker than usual. It contained a little gum and much gallic acid, but no tannin nor resin.

The decoction of the coffee thus treated still contained gum, and a little aroma, but not the least trace of tannin or resin.

The cinders of coffee contain carbone, iron, lime, and muriate of potash.

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Mr. Paysse, in an elaborate memoir read to the Société de Pharmacie by Mr. Parmentier (see the preceding paper), asserts, that the precipitate formed in the decoction of coffee by sulphate of iron is soluble only in nitric, sulphuric, phosphoric, and oxalic acid; and that coffee does not contain gallic acid, but an acid of a peculiar nature.

Isle of Bourbon coffee was boiled in water for two hours. The decoction was yellowish green; a little albumen was separated, and some oxygenized extract was precipitated. It rendered infusion of litmus green.

A part of this decoction was precipitated by sulphate of iron. The precipitate was very dark blue, and was redissolved by oxygenized muriatic acid, acetic acid, whether strong or weak, tartaric acid, citric acid, and even benzoic acid.

The muriatic acid rendered the liquor yellow, but it afterwards became clear, and let fall oxygenized extract; the addition of ammonia redissolved this precipitate, and the liquor became of a fine brown-red colour.

The immediate precipitate by sulphate of iron, dissolved in acetic acid, was acted upon in a similar manner, but the colour was violet blue; it was redissolved by ammonia.

The other acids yielded nearly the same kind of precipitate as the muriatic. The precipitate formed by the gallic acid and sulphate of iron exhibited the same phenomena.

The remaining portion of the decoction was precipitated by muriate of tin; the precipitate was well washed, and being floated with water, sulphuretted hydrogen gas was passed through it. The mixture immediately acquired a brown colour, which became deeper as the process went on; a hydrosulphuret of tin was precipitated, and the liquor being filtered was evaporated to one fourth. This product is considered by Mr. Paysse as a peculiar acid; but it appears to be nothing but the gallic, as it exhibits the same phenomena; and was perfectly similar to gallic acid extracted from galls themselves by the same process. All therefore that can be inferred is, that coffee contains less gallic acid than galls themselves. It is, indeed, possible that this acid product may in some cases exhibit a few peculiar phenomena; but this is common to all vegetable principles, which vary slightly in their properties according to the substance from which they are extracted, as is shewn by the differences which exist in the various gums, sugars, fæcules, &c.

From the foregoing experiments we may deduce the best method of making coffee, which ought to have an agreeable odour, a slightly bitter taste, a good colour, and a certain density; to which latter quality the Orientals pay so much attention as to reduce their coffee to a very fine powder, and to omit straining it.

The quantity of coffee necessary for use that day ought to be divided into two equal parts; one of which is to be roasted of a light brown, i. e. till it loses one eighth of its weight; the other half to be roasted dark brown, i. e. till its has lost one fifth of its weight. These two portions are then to be mixed together and pounded in a mortar.

In regard to this preparation of coffee, Mr. Cadet remarks, that his uncle Mr. Cadet-de-Vaux found that pounded coffee retains its aroma far better than that which is ground. The desire to retain this principle is general among coffee-drinkers. In India and some other places they add a little butter to the coffee when it begins to turn brown, just sufficient to varnish the surface of the grains; the butter retains a part of the essential oil which would otherwise escape, but it sometimes gives the coffee a disagreeable taste. Another method is, to spread the roasted coffee while yet hot upon a sheet of white paper, and to sprinkle it with sugar, which absorbs the oil, and of course retains the aroma. This method, however, renders us uncertain as to the quantity of the sugar to be added to the coffee when drank. The aroma is in general conceived to be united with an essential oil; but Parmentier has observed, that when hot roasted coffee is wrapped up in filtering paper, the oil renders the paper transparent and greasy for more than a year, as though it were a fat oil; and yet an oil of that kind cannot be obtained either by pressure, boiling, or by the action of caustic alkalies.

Having thus roasted and pounded the coffee, pour upon two ounces of the powder four cups of cold water, and place the strained infusion on one side; then pour three cups of boiling water upon the same coffee, and mix the liquor which runs from it with the former. By this means six cups of good coffee will be obtained, which should be quickly heated at the time when wanted to be drank, but not allowed to boil. Vessels of porcelain, earthen-ware, or silver, should be used for the infusion.

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*Observations.*—We have here two chemists of reputation who assert facts diametrically opposite: Paysse, that coffee contains an acid in a free state and of a peculiar nature; Cadet, that the decoction is never acid, and that the acid afterwards obtained is merely the gallic.

The most probable solution of the first difficulty is, that Paysse operating in Holland made his experiments upon coffee newly imported; and that Geoffroy (who asserts the same) made his while

he was in England or Holland; whereas Cadet examining coffee at Paris, used of course that which was older and drier.

In regard to the second, it is evident that Cadet is for generalizing the nature of the principles obtained from vegetables and animals, whereas we think with Thomson, that the names of sugar, starch, gum, &c. ought to be regarded as generic titles only, the same as metal, salt, &c. It certainly would contribute to the accuracy of our knowledge if the history of the various modifications, as Mr. Cadet calls them, of vegetable principles were separately considered, instead of their being blended together, as usual, with intricate statements of their variations.

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*On the Sugar of Grapes. By Mr.* Proust.—*Ann. de Chim.* Nos. 170, 171.

There are in effect several species of sugar: 1. Dry, brittle, crystallizable sugar, such as is yielded by the sugar-cane. 2. Clammy sugar, melting with the slightest heat, as manna. And, 3. Mucous sugar, which is mucilaginous, and always liquid.

Honey is almost totally soluble in alkohol; a small quantity of wax is separated; and there is also a portion of gum which separates in time. The colour of the yellow honey depends upon an extractive principle which is precipitated by muriate of tin in the form of a yellow lake: the white honey contains scarcely any of this principle, and is most apt to candy.

Alkohol applied to the finest white honey in a quantity not sufficient to dissolve the whole, separated a white powder, which when washed with a little more alkohol left a pulverulent sugar. This sugar boiled with water to a thick syrup did not crystallize, but it granulated and formed crusts, which rose an inch above the surface like cauliflowers. When the treacle was well drained off, this sugar was perfectly white; it did not become moist. Its taste was less sweet than that of cane-sugar, and left a farinaceous taste on the tongue. When burnt it exhaled the same odour as sugar. It was totally soluble in alkohol, and again separable in grains by evaporation. The nitric acid converted it into oxalic acid.

The liquid sugar separated from the other is perfectly transparent, and appears in the form of a thick turpentine; it attracts moisture. Although the best white honey yields only 25 or 26 per cent. of granular sugar by washing with alkohol, 39 or 40 per cent. may be obtained by letting the solution of the whole honey in alkohol evaporate spontaneously.

It has been supposed that manna owed its peculiar properties to the presence of extractive matter; but on adding muriate of tin to a solution of it, scarcely any precipitate was formed. Manna is entirely soluble in alkohol, and the solution by spon-

taneous evaporation forms very fine crystalline filaments, and grains which resemble fine white mushrooms. The manna thus refined still retained its peculiar taste and moist feel. It forms with nitric acid the same two acids, as gum, sugar of milk, &c.

Many vegetables contain a kind of sugar, but we are not certain whether they are similar to that of the sugar-cane. The juice of the maple-tree yields 5 per cent. of solid sugar, and there is reason to suppose that it also contains treacle. Travellers say it melts with more difficulty than cane-sugar, that it does not render things so sweet, and that cane-sugar is mixed with it when used for confectionary. The Arabs also extract a species of sugar from the pods of the carob-tree. This sugar is uncrystallizable, and contains an extract which renders its taste very disagreeable. The beer made from it resembles that of treacle.

A crystallizable sugar different from cane-sugar, exists in gooseberries, cherries, apricots, grapes, figs, and several other fruits. These crystals are pulverulent, and so small that their form cannot be determined. The candy which forms in preserved gooseberries and cherries comes from the fruit and not from the sugar employed in the process; for these concretions dissolved in alkohol and separated by evaporation, retain their granular form. But as preserved apples, quinces, medlars, plums, and peaches do not candy, it is probable that these fruits do not contain this species of sugar, but only the other kind. In all these fruits the saccharine product is mixed with gum, extractive matter, malic acid, citric acid, tartar, sulphate of lime, &c.

The liquid sugar, formerly called mucous sugar, is thought by Deyeux to be the only one that is self-fermentiscible, as the other requires the addition of a ferment. And the whole business of the sugar-refiner is to separate the liquid sugar or treacle from the crystallizable kind.

A slice of sugar-cane reddens infusion of litmus, but the taste of the sugar overpowers that of the acids contained in the juice. As to the juice of the cane, it is precipitable by the oxalic acid and by barytes, which shews the existence of sulphate of lime. The concentrated solution of platina does not form any precipitation on account of there not being any salt of potash present in the juice. Alkohol throws down insoluble threads, which are pure gum; and afterwards the sulphate of lime also falls down. The syrup thus cleared of the gum and sulphate of lime, precipitates the nitrates of lead and silver. Lime-water also precipitates the syrup, and renders it green, which shews the presence of extract: this also appears by the whitish lake thrown down by muriate of tin.

The syrup distilled with weak sulphuric acid does not shew any signs of vinegar. When boiled with chalk, filtered and concentrated, alkohol separates from it malate of lime, but in very

small quantity; so that the use of so much potash and lime as is commonly employed cannot be explained at present. The cane infused in water yields a solution which by concentration throws off a little before it boils a greenish feculent scum, the same as is furnished by gooseberries, &c. and which yields ammonia by distillation.

The sugar-cane commonly yields half its weight of expressed juice, which varies in strength from 5° to 14° of Baume. A hundred weight of the strongest juice yields 25 lb. 11 oz. of sugar, which produces $\frac{1}{3}$ or less of refined sugar. The proportion of the crystallizable sugar to that of the treacle probably varies, but it has not yet been discovered.

Considering the increasing price of cane-sugar, and the immense quantity of grapes which are yearly spoiled in Spain for want of a market for the wine that might be made from them, Mr. P. proposes the making of sugar from them as a means of bringing their produce to market.

Verjuice contains tartar, the sulphates of potash and of lime, citric acid in great quantity, a little malic acid, extractive matter and water. When the grapes have ripened, their juice contains, besides the fibrous and calcareous pulp, some glutinous fecule, both which are best separated by heating the juice to ebullition, and then passing it through flannel. The strained liquor contains some of the fecule, granulating sugar, liquid sugar, gum, and extractive matter, which last is either white or red.

The different kinds of grapes yield from 18 to 32 per cent. of inspissated juice, or *raisiné*, which, when the grapes are perfectly ripe, is only agreeably acid. The acids however are apt in the inspissation to produce a sharp and burnt flavour; and this alteration diminishes the fermenting quality of the juice. On account also of these acids the use of this *raisiné* is incompatible with that of milk. The *raisiné*, when boiled to a certain degree, soon forms a spongy mass; the crystals when drained are a mixture of crystallizable sugar and tartar.

To get rid of the acids in the raisiné it is necessary to add chalk (or whiting) to the juice of the grape, and having left it to settle till the next day, the fecule unites with the earth, and is separable by straining; it is then to be boiled and the scum taken off. The addition of the white of egg is superfluous. The syrup is coloured although a white grape was used. It congeals in eight, fifteen, or twenty days, into a yellow, granular, consistent mass. The crystallization takes place first in those syrups that retain 40 per cent. of their original weight, then in those of 36 and 35. Syrups containing only 34 or 32 do not crystallize. When boiled down to a consistency, it resembles brown cane-sugar: a pint weighs 25 ounces. It has no peculiar smell. Its taste is that of sugar mixed with the taste of baked fruit. One hundred pounds of it contain 75 lb. of crystallizable sugar,

27 lb. 7 oz. of liquid sugar, 5 oz. of gum, 4 oz. of malate of lime, and a very small quantity of extractive matter, as the treacle, notwithstanding its colour, is perfectly transparent.

This muscovado sugar does not sweeten things so much as the common; it requiring $2\frac{1}{2}$ oz. to produce the same effect as 2 oz. of cane muscovade. The solution does not redden litmus, nor precipitate glue; but it is precipitated by muriate of tin.

When the solution of this muscovade is brought to a proper consistence, it forms, in a few days, a granular mass, rendered moist by an interposed liquid which separates by draining. The treacle thus separated is superior to the common, as it is free from the lime, alkali, bullock's blood, &c. which contaminate the latter, and moreover has not the peculiar smell of cane-treacle.

The solid part is not crystallizable like cane-sugar; its grain is pulverulent, and the mass has but little consistency: but it is probable that professional refiners may discover the means of giving it that solidity. When purified as much as possible, it has the taste of a pure sugar without leaving an aftertaste of any kind. It is still inferior in sweetness to refined cane-sugar, and has more analogy to that of honey or of the maple. As it is less soluble than cane-sugar, it separates more easily from the treacle. In burning, distillation, or treatment with nitric acid, it does not exhibit any remarkable difference from that of the cane.

The muscovado grape sugar is much disposed to fermentation; one part by measure dissolved in three of water exhibits 17° of the hydrometer, and yields four measures of a strong wine resembling Malaga. Fabroni and Thenard thought the fecule was an essential matter to cause must to ferment, but when the juice of the grape is carefully freed from it, it works with equal ease. The true cause of the fermentation is the liquid sugar. The superiority of the muscovade to the farinaceous grains used in the north of Europe is evident, as malt contains only 15 per cent. of saccharine matter, and therefore 7 bushels of malt are only equal to 1 of grape muscovade. Now the sweetest grapes may be had in Madrid for 30 rials (15s.) the cwt. and cheaper in the country; hence Mr. P. recommends the exportation of grape muscovado sugar to supply the northern nations with wine of their own manufactory in lieu of beer.

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## *Experiment on the Absorption of electric Light by different Bodies.*

*By Mr.* Wm. Skrimshire, *Jun.—Phil. Journ.* No. 63.

A well-known experiment, in which sugar is rendered luminous by passing an electric shock over or through it, induced Mr. Skrimshire to examine how far other bodies possessed the same property.

The subject of each experiment was placed on a brass plate, fixed horizontally on the knob of the prime conductor by a piece of brass wire, and the spark was taken from it by the ball of the discharger. It was afterwards placed upon a wooden stand, and the shock of a Leyden phial passed over it, about a quarter or half an inch above it, by resting the points of the discharging rods on it an inch or more from each other. To make the effect more apparent, the eyes should be closed till the explosion is heard.

All calcareous substances tried in this manner were more or less phosphorescent.

Sulphuret of lime was the most luminous of all matters examined, and when mixed with white of egg and spread on a board the tenth of an inch thick, dried, and then exposed to the electric shock, exhibited the appearance of a beautiful shower of fire.

Chalk was extremely luminous, and rhombic spar reflected the sparks so intensely as to illuminate the whole table with a brilliant white light. Ketton stone was next to chalk in its phosphoric appearance. Sulphate of lime was beautifully luminous, but its light was very evanescent. Muriate of lime was somewhat more phosphorescent than the nitrate; and all the fluates of lime absorbed the light freely.

Bone was very luminous by the electric light, and the enamel of teeth still more so. Ivory was also similarly affected, became transparent during the shock when thin, and was so easily perforated by it, that a discharge from a small phial perforated from nine to twelve thin plates of it.

Phosphoret of lime is but slightly luminous when the explosion is made above its surface, but is most remarkably inflammable by a very small shock passed through it; the flame is readily extinguished, so that a piece the size of a filbert may be set on fire several times.

Many experiments were tried with the testacea and lithophyta, all of which were luminous; and the author thence supposes, that this property is universal among them, and also among all calcareous fossils, of which he tried several marbles, lime-stones, stalactites, and spars, with success.

Quick lime fresh from the kiln was the least luminous of this species.

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*Description of a Blow-pipe. By Dr.* W. H. Wollaston.—*Phil. Journ.* No. 63.

This instrument differs from those in common use, by having the straight part of the tube formed in two pieces, one of which is sufficiently smaller than the other to lie inside it when not in

use, a thin smaller piece, constructed so as to be placed obliquely across the end of the least of the other pieces, answers the purpose of the curved part of the common blow-pipe. This oblique piece is perforated to admit the end of the other tube; at the upper end it is closed, and in the other extremity a peg of wood is inserted drilled through to admit the tip, which is intended to be removed occasionally to clean it from any casual obstruction. The interposition of the wood prevents the communication of heat to the other parts of the blow-pipe. This oblique piece when taken off fits into the top of the largest of the other pieces.

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## REVIEW OF SPECIFICATIONS OF PATENTS

PUBLISHED IN THE REPERTORY OF ARTS, &C. IN THE MONTHS OF OCTOBER, NOVEMBER, AND DECEMBER 1806.

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*Mr.* DAVID HARDIE's *Patent for an Improvement in and upon Cranes for raising and lowering Goods. Dated March* 1799. —*Rep. Arts,* No. 53, *New Series.*

THIS crane is in fact a walking-wheel on the principle of the wheel used in China for men working at the chain-pump in raising water to the higher grounds employed in the culture of rice. The wheel is 6 feet in diameter, and may vary in length from 6 to 12 or more feet, according to the number of men intended to be employed in working it: on the outside of the wheel are placed 24 equidistant steps, after the manner of float-boards in a mill water-wheel; these are for the men to tread upon, where the steps are found at a height rather exceeding that of the axis, or just above the position where the plane of the steps becomes horizontal. At one end of the wheel and upon its axle is the crane-rope barrel of a diameter suited to the draft of goods and the number of men generally allowed. The men ascend by a flight of steps to a platform on the same horizontal plane as the axle of the wheel, and which reaches to within a few inches of its rim; on this platform is a seat on which the men may rest themselves at the intervals between the operations. On the general frame-work which supports the wheel, there are placed above it, at suitable distances and convenient heights, both vertical and horizontal handles for the men to take hold of with both hands, when treading on the steps: sometimes both hands are applied to the vertical handles; at others, one hand to a vertical and the other to a horizontal handle; and at others, both

hands to the horizontal handles; thus producing by either pushing or lifting, or both, a variety in the action, and when necessary a considerable augmentation to the force. There is a pawl which drops in at every step to prevent the wheel and its incumbent weight from overpowering the men at any time: it has at its lower part a cord with a loop to pass over one of the horizontal handles, near the extremity of which there is a notch sufficiently deep to retain the loop when drawn into it, for the purpose of raising the pawl to disengage it from the wheel preparatory to any operation of lowering.

Now it is obvious, that by treading on the steps as they arrive at the position just above the horizontal plane passing through the axis, the men both ascend and descend nearly in the same vertical direction, of consequence the greatest possible velocity is produced without any unproductive labour; and the men are enabled to maintain the action by means of a hold of an upright handle in each hand, or occasionally to augment the action by pushing at these handles. Further, by taking hold of the horizontal handles, each man can, by an act similar to that of lifting, augment the force arising from his weight through all the degrees from about 150 to 300lbs. So that the same number of men can perform many operations of raising greater drafts than usual; such as with the common walking-wheel or most other cranes could not be accomplished without additional men; and the pawl which drops in each step provides in the most effectual manner for the safety of the men; besides, that the distance between the edge of the platform and the revolving wheel is by no means large enough for a man to fall through.

Mr. Hardie has likewise contrived a method of operating without a gibbet, in which he places the crane at the top of the warehouse so as to allow the crane-rope to drop directly down from the barrel of the crane in front of the loop-holes; and at the upper floors, where the shortness of the rope diminishes the swing of the goods in or out of the loop-hole, he has provided a sliding floor immediately under the floor of the warehouse, which one man draws out or in, by pulling a cord, with the greatest ease, to receive or deliver the goods by a truck at the loop-hole. The part of the warehouse floor which is immediately above the sliding floor consists of a thin plate of cast iron, which allows the truck to run off the one on the other without any sensible obstruction. Thus more than one man's labour in five or six is saved by getting quit of the friction of the pulley of a gibbet; and a still greater saving of labour is effected by accelerating all the movements at the loop-holes.

Mr. Hardie's lowering regulator is invented for the special purpose of removing the evils and dangers attendant upon the usual practice of lowering goods by the brake and brake-wheel. The part essential to this invention is a cast-iron box fixed firmly

to a floor, and divided into two cylindrical compartments; each 10 inches long, one of 4 inches diameter, and the other of 2 inches diameter: these are both filled with oil, a liquid not subject to any material change by frost; or they may be filled with water in summer and mild weather, and some spirituous liquor (gin for instance) in frosty weather. These two cylinders communicate by apertures at their top and bottom; the smaller compartment having a cock with its axle passing through the side of the iron box, guarded by a stuffing box, and a quadrant with equidistant notches fixed at its end, to receive an iron claw which retains the cock in any proposed situation, and shews the extent of its apertures when opened. The larger compartment has a piston with its rod passing through the top of the iron box (guarded here also by a stuffing box), and passing through a guide: this rod is connected with a joint moved by a crank, which is turned by a pinion of about 6 teeth, and this pinion is moved by a wheel of a size suited to the diameter of the barrel of the crane, and the weight of the goods commonly lowered: this latter wheel is fixed to the axle of the crane by a simple mode of connexion, which admits of its being disengaged during the operation of raising; it is also provided with the barrel-rope and counter-weight, which are commonly used for the purpose of winding up the slack crane-rope on the barrel of the crane, to be ready to repeat the operation of lowering.

Now if the cock were quite shut, the oil or other liquid confined between it and the piston would prevent the piston from moving, and of course hinder the goods hanging from the wheel, &c. connected with the pinion from descending: but, if the cock were opened a very little, the oil would pass slowly through it, and would therefore allow the piston to move up and down slowly, and the goods to descend slowly also; and in like manner a farther opening of the cock will permit the load to descend with a greater velocity: thus the cock, by being more or less opened, gives the precise velocity desired to the descent of the goods, whatever their weight may be.

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*Observations.*—The preceding description, although given without any figures, will, we trust, enable the reader to understand the nature of Mr. Hardie's inventions. The chief advantages resulting from them are too obvious to require our dwelling long upon them. Although the crane is a walking-crane, yet it is free from the dangers and disadvantages of the common walking-wheel; for as the men walk on the outside of the wheel instead of inside of the rim, they are in consequence of the adjoining platform and the use of the pawl free from danger; while during the whole time of their labour they can walk in an upright posture well suited to free respiration; and farther, as they act at the extremities of horizontal levers, their weight and occasional mus-

cular force act with all the advantage they can have; while the modifications they can make at pleasure in their action, will frequently supersede the necessity of calling in any more men, even when a double load is to be raised. Indeed, there can be no doubt that with a crane of this construction, any given number of men will raise as least twice as much in a day, as they could in a common walking-wheel, or working at a capstan, or at a wheel and pinion. And as to the lowering apparatus, it possesses, as Mr. Gregory remarks, "a much higher degree of perfection in lowering than any of the other cranes. The means afforded of regulating it to lower either small or great weights with facility, expedition, and safety, and without depending during the operation on the precarious attention and management of a man, render it in our opinion far preferable to the hazardous and limited mode of lowering goods by the brake: while, with respect both to safety and great saving of labour, it obviously surpasses the modes of lowering by the capstan and the walking-wheel, which require nearly the same number of men to lower that they take to raise any weight."

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*Messrs.* DONKIN *and* MAUDSLAY*'s Patent for a new Method of combining Wheel-work. Dated July* 1806. — *Rep. Arts,* No. 53, *New Series.*

IN the combination of wheel-work, to which this patent relates, a toothed wheel of a large size is turned round by one of a smaller size, set in motion by hand or otherwise; on the same axis with the large wheel are placed two of a smaller size, one at each side; one of these is attached to a drum, for coiling up rope, and is moveable on the axis; the other is fixed to the frame-work, so as to be immoveable, and its centre only serves as a fixed socket for the end of the axis. Through the large wheel, between the centre and circumference, passes an axis at right angles, and moveable in its place, to each extremity of which is attached a smaller wheel, so fixed that the motion of one must be communicated to the other; the teeth of one of these last wheels lock into those of the smaller moveable wheel connected with the drum, and the teeth of the other are inserted in those of the fixed wheel first described. By this mode of combination, when the large wheel is turned round, it carries round with it the axis of the smaller wheels, that passes through its sides; one of these wheels will then be turned round by the teeth of the fixed wheel, and turning the other small wheel on the same axis with it, by its operation give motion to the drum by the wheel with which it is connected.

In the manner of giving motion to this engine described, it will operate as a crane, or so as to gain power by reducing velo-

city. By reversing the movement and applying the impelling power to the drum, it may be also used as a machine for giving a great velocity of motion to any machinery acted on by the teeth of the large wheel.

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*Observations.*—The substitute for the crank, used in some steam-engines (in which a toothed wheel fixed to the lower end of the balance-rod turns a wheel connected with the fly), seems to have suggested the idea of the described apparatus to the patentees: wheels arranged in this manner may certainly be made to produce a greater number of revolutions in the last from the impelling power, or the reverse, than can be done by placing the same wheels on a fixed frame in the usual manner; but then the advantage of this is very little, if any, when such a number of wheels are required to produce it. In common cranes any weight required is raised by one wheel turned by a pinion. In the above patent machine no less than six wheels and pinions would be required for the same effect: for all mechanical purposes, engines, composed of numerous parts, are objectionable, unless they possess very great and obvious advantages over those of a more simple structure; and this is particularly the case where they are to sustain great force. This objection we think may fairly be made to the engine which is the object of this patent.

We however think the arrangement of the wheels extremely ingenious, and are therefore sorry that the evident complication and multiplication of parts of the engine are likely to prevent its producing advantage to the inventors in the manner they propose.

The specification of this patent is worded with great clearness and precision.

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*Mr.* Henry Maudslay's *Patent for a Press for printing Calicoes and other Articles. Dated July* 1805.—*Rep. Arts,* No. 54, *New Series.*

In the common press for printing calicoes (which is on the same principle as the rolling copper-plate press), the part which sustains the copper plate is made to pass under the roller by a sliding horizontal movement; in Mr. Maudslay's press the part for this purpose is attached at right angles to a lever or "swinging frame," which turns on a pivot at the bottom of the press, by which means the plate is carried under the press-head, called in the specification a cylinder. The lever which sustains the plate is made to move to and fro, and when the plate is thus brought under the press-head, a crank or eccentric wheel turned by hand draws upwards "two connecting rods," attached to the axis of the lever or "swinging frame," and forces the plate upwards against the cylinder or press-head. The crank is connected with a fly and with small rollers, placed in due positions, and pro-

perly connected with the general machiney to convey the calico or other stuff along with the woollen cloth of the press, so that each part may successively receive the impression of the plate. The whole are turned round together by machinery, which consists of toothed wheels so arranged, and of such relative sizes, as to give each part its due velocity in the manner usual for such motions.

The press-head or cylinder is made hollow to admit steam or hot water, by a stuffed joint and tubular axis, to give it a degree of heat useful in some operations.

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*Observations.*—The specification of this patent is of doubtful meaning, the description and drawing being contradictory. The part called in the specification "*the cylinder*," and which any one would suppose from such appellation to have a use and motion similar to *cylinders* in other presses, is not represented in the drawing as a cylinder, but the segment of one with a flat side placed horizontally, and is immoveable, against which flat part the plate is pressed upwards. It might with as much propriety be called a tetrahedron as a cylinder.

We are inclined to think the action of the crank in many cases would not have sufficient force to effect the pressure necessary, particularly where large plates are used, and that as its operation also is limited, it is inferior as a pressing power to that of the screw, or the rollers in the common presses.

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*Mr.* R. W. King's *Patent for a Method of manufacturing Tin Plates into Covers for Dishes and Plates. Dated May* 1806.—*Rep. Arts,* No. 54, *New Series.*

The specification of this patent contains merely directions for making moldings on covers for dishes and plates, in a manner stated to be different from the usual method: this consists in first forming a hollow groove all round the edge of the cover with a bouge hammer, after placing it on a piece of lead or block, having a suitable hollow sunk in it. The cover is then laid on a tool, composed of a support of steel or iron cut into the form of the reverse of the intended molding, so as that its cavities may correspond with the projections of the swage or hammer annexed to it, whose face has the true molding cut on it: this swage has a part projecting from it at right angles, like the handle of a hammer, whose farther extremity is jointed to another piece that projects from the support, by which means it is retained in its place directly over the support: the edge of the cover being placed between the swage and support, is formed into the intended molding by striking the swage with a hammer: the rest of the cover is finished in the usual manner. The molding is directed to be formed before the top is soldered to the cover, and the sides are ordered

to be somewhat deeper than usual, to allow for making the moldings on them, instead of having a rim added as is usual.

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*Observations.*—The title of this patent has but little correspondence with the specification; the first relates to the manufacturing in general, the latter solely to a method of putting on a molding.

The method of making moldings on thin metallic plates by tools with corresponding indentations, is of very old date: similar ways of working have been formerly much used in various manufactories.

The only novelty that can be claimed under this patent is in the application of this method to the making of the moldings on tin covers.

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*Mr.* William Deverell's *Patent for Improvements in the Mode of giving Motion to Hammers, Stampers, &c. by various Powers in common Use. Dated June* 1806.—*Rep. Arts,* No. 54, *New Series.*

The specification of this patent relates solely to the application of the power of steam to the purposes mentioned in the title. In the usual manner hammers, stampers, bellows, and the other machines to which the patent relates, are put in motion by apparatus communicating with the rotative part of the steam-engine: but Mr. Deverell directs that the communication between the piston-rod and the said machines shall be made at once; that hammers shall be moved by being directly attached to the piston-rod, and stampers, bellows, knives, and shears, either by direct communication, or the intervention of single levers.

For hammers and stampers the patentee mentions, that the operation of a spring may be added to the piston of the steam-engine, by confining air at one side of it in the cylinder, and admitting the steam to the other side only; and that the confined air may be compressed to any degree desired, by letting in water into the cylinders through cocks from an adjoining vessel. He also mentions that the hammers may be made to work *without springs,* by making them of a weight corresponding to the pressure of the steam.

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*Observations.*—The use of the intervention of the various parts customary between the piston-rod and the operating tools or machines mentioned, is to give them their *proper velocity* of movement, and multiply the percussions or the other motions as required. We apprehend this would be extremely difficult or nearly impossible to perform by Mr. Deverell's method in some cases; for instance, a mill forge hammer is made usually to strike some hundred blows in a minute; how could the piston of a steam-engine be

made to give an equal number of alternating movements in the same time? Again, Mr. Deverell mentions that forge hammers may be made to operate by their weight alone without springs. We apprehend the blow could not be given thus with sufficient velocity. Springs are every where within our knowledge used for the largest forge hammers, though attended with considerable trouble and expense; which shews an opinion entertained by engineers of their indispensable advantage.

The method of using the spring of air confined in a cylinder beneath a piston, mentioned by the patentee, was practised by Mr. Watt a great many years ago, in some of his first steam-engines.

We think Mr. Deverell's method may be used to advantage for forge bellows, some species of stampers, and in general for movements of moderate slowness; but cannot recommend its trial for quickly repeated motions, or percussions speedily reiterated.

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*Mr.* Richard Wilcox*'s Patent for Machinery for glazing and graining Leather. Dated March* 1806.—*Rep. Arts.* No. 54, *New Series*

This machine for glazing and graining leather, consists of a large iron or wooden cylinder, about 4½ feet long, and one foot diameter; against which two rows of small rollers (each 2½ inches in diameter, and 4 or 5 inches long) are caused to press by springs, bent so as to form a portion of a circle about 14 inches in diameter, and of a strength equal to about 200lb. weight; each of which has an adjusting screw to regulate its pressure: these small rollers are placed so that the centre of each roller in the second series is opposite the interval between two of those in the first series, by which every part of the leather passed under them is acted on. They are grooved or fluted; and the whole is so connected with other machinery, that when the large roller moves three eighths of an inch, the small rollers make an entire revolution.

The skin prepared in the usual manner, is made to pass between the large and small rollers, which grain and glaze it at the same time; the pressure being so regulated, that the small rollers glide or slide easily over the skin, which also are made to turn different ways in each row, to prevent the skin from being creased.

The specification contains another method of graining the leather: the skin in a damp state, is passed between smooth rollers in the described machine to glaze it, after which it is placed in contact with a copper, or other metallic plate, engraved or etched, so as to produce an impression similar to that produced on the skins by hand, with which plate it is passed between rollers similar to

those used for copper-plate printing. The skin is afterwards either again passed under the glazing rollers to complete the gloss, or else receives a coat of elastic varnish, according to the purposes for which it is intended. This latter method admits of flowers, and various other ornaments, being impressed on the skin.

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*Mr.* ANDREW FLINT's *Patent for a Machine, which may be used as a Steam-engine, and for other Purposes. Dated Nov.* 1805. *Rep. Arts,* No. 55. *New Series.*

MR. Flint describes this engine first as it may be moved by steam, which thus is intended to form a rotative steam-engine.

It consists of two hollow cylinders, one of which is so much smaller than the other that it may lie within it, leaving an interval all round between it and the outer cylinder equal to about a fourth of the diameter of the latter: they are both to be turned true, and placed concentrically: they are also furnished with flat tops and bottoms, either cast with them, or fastened by screws, so as to be steam-tight.

The inner cylinder has a partition in its middle parallel to its top. It revolves within the outer cylinder, and has a pipe passing through the centre of its top and that of the outer cylinder, from its upper division (in the latter of which tops it is made steam-tight by proper boxes and stuffing); this pipe communicates with another, that passes to the boiler, having the parts in contact with it also made steam-tight, so as to admit of its circular motion. Another pipe, in a similar manner, passes from the lower division of the inner cylinder, through the bottom of the outer cylinder, to form a connexion with the condenser. From the side of the inner cylinder projects a piece of the nature of a piston, which fills the section of the cavity in the line of the radius, between the two cylinders: this rectangular piston is so contrived that it may be stuffed round the edges, so as to be steam-tight. The outer cylinder has two semi-cylindrical cavities cast in its sides opposite to each other, with their open parts turned inwards; each of them is of sufficient size to admit within it a portion of a smaller cylinder, which is placed upright between the two large cylinders, somewhat exceeding in diameter the interval between them: in these spaces are placed two parts that serve somewhat the use of valves, and which retire alternately into the lateral cavities of the outer cylinder to admit the piston to pass by them. These valves consist each of the segment of a cylinder of the height of the inner cylinder, and of the diameter before mentioned, connected with a circular top and bottom, turning on centres: and an axle from the top of each passes through the top of the outer cylinder, through steam-tight joints, by which it may be turned round from without.

Annular projections are cast to the bottom and top of the inner cylinder, and of each of the valves, which fit in suitable cavities made for them in the outer cylinder; in each of which cavities a loose ring, of the same dimensions with it nearly, is placed, and oakum, or other stuffing, being placed between each of these rings, and the annular projection over them, they are pressed inwards by screws so as to make steam-tight joints. Stuffing cases also are placed in the semi-cylindrical cavities of the outer cylinder, to render the junction of the valves with them steam-tight, and the portion of the valve which occasionally touches the inner cylinder is supposed to fit it so closely as to be steam-tight without any stuffing.

At one side of the piston a perforation is made into the upper cavity of the inner cylinder to admit the steam; and at the other side of the piston a similar perforation is made into the lower cavity of the inner cylinder to form a communication with the condenser.

An arm projects from the revolving steam-pipe, which as it moves round strikes against other arms projecting from the axles of the valves, and opens them in succession; while connecting rods passing between the arms of the valves and other arms, are so arranged as to close one valve when the other is opened.

The machinery being fitted together as described, the steam when admitted into the steam-pipe will pass on through the upper cavity in the inner cylinder to the space intercepted between the two large cylinders, the shut valve, and the piston, and will impel the piston round, till it has passed the open valve; after which the revolving arm before mentioned closes the open valve, and opens the shut valve, and this operation is successively repeated. In the mean time the confined stream enclosed in the space first mentioned, when the valve that was first shut is opened, escapes into the lower cavity of the inner cylinder, and from thence to the condenser, and thus maintains that inequality of pressure at the opposite sides of the piston which causes it to revolve. An open space is left in the top of the outer cylinder, through which the rectangular piston may be packed: this space is closed, after this operation, by a door, or stopper, screwed down so as to be steam-tight.

The patentee states, that this machine may be worked by the pressure of a column of water, instead of steam, by letting the water flow into the pipe described in it for admitting the steam: and that it may also be used for raising water, or as a rotative pump, by putting it in motion by any external force, and placing the pipe, described as passing to the condenser, beneath the surface of the water to be raised, which will then flow out of the upper pipe.

In the description, the engine is supposed to be placed with its axis in a vertical position, which is that preferred by the patentee;

though he mentions that it will act in various other positions also.

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*Observations.*—We have already given our opinion of two circular steam-engines, in our first and sixth numbers; stating their disadvantages from friction, and the difficulty of packing, and keeping them steam-tight. The imperfections of this engine in these respects are very considerably less than of those alluded to. The friction would be much less; and by the ingenious contrivance of the annular projections from the inner cylinder and valves, running in corresponding cavities, fitted with rings to close the packing by screws, and by the stuffing cases for the back of the valves, most parts of the engine could be made steam-tight: but in steam-engines, as in vessels to hold water, it is of but small advantage to have four fifths of their enclosing parts impervious to the contained substance, if the fifth part lets it pass freely. A defect of this kind exists in Mr. Flint's engine; for where the valves come in contact with the inner cylinder, no stuffing, or any other contrivance whatever, is placed to keep the parts steam-tight; therefore, we think that though for a short time the engine might work, if the parts were fitted very truly together, yet before long the sides of the valves would be so worn and ground down by the inner cylinder revolving against them, that a passage would soon be opened for the steam, by which it might escape without having any action on the engine; which, if it did not altogether stop from this cause, must at least be worked to great disadvantage and loss. This defect would not be so material in the use of this machine as an hydraulic engine, but would certainly even here be considerably injurious. But both as an hydraulic impeller, and as a pump, its complication and the trouble it would require to stuff it, and keep it in order, would operate against its use. It might, perhaps, rank higher as an hydraulic impeller or prime mover, than for any of its other purposes; but as a pump or engine to raise water, it is far excelled by the hydraulic screw of Andrew Wirz, and by several other well-known machines, in simplicity, effect, small liability to derangement, and facility of repair.

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*Mr.* William Cooke's *Patent for Improvements in the Construction of Waggons, or other Carriages, with more than two Wheels. Dated Oct.* 1806.—*Rep. Arts,* No. 55. *New Series.*

The object of this patent (for its object is single, though the title would induce a supposition that it related to several), is to secure the right to construct carriages of four wheels with one of the axles so arranged as to admit of a libratory motion vertically on its centre (the hind axle will be found to be most convenient

to fix in this way); and by the play up and down which this will permit to the wheels, every wheel will have a bearing, though the road should be very uneven, without straining any part of the frame-work of the carriage; which injury must take place, more or less, in all four-wheel carriages on the usual construction when used on rough roads.

Various methods are described by the patentee for allowing the axle to have this motion; of which one of the simplest is to perforate the middle of the axle horizontally with a cylindrical hole, through which a gudgeon passes in the same direction, properly secured to the perch, or other part of the frame, so as to prevent the axle from slipping off, or from having any other motion round its centre but the vertical movement described. The axle of course must be made sufficiently strong to admit of this perforation, as must likewise the other additional parts for the force they are to sustain.

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*Observation.*—A contrivance for the same purpose as that of this patent was several years ago used in some of the mail-coaches first made by Mr. Vidler under the sanction of a patent. The perch in them was made double; one part was connected with the hind wheels, the other with the fore wheels; and the two parts were passed one over the other, and secured in their places by annular clasps, which admitted of sufficient play to the axles vertically to prevent all strain to the frames.

Perhaps the general smoothness of the roads rendered the use of these perches unnecessary. No other reason can be conjectured for returning to the old method for these coaches in this particular.

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## *Mr.* George Wyke's *Patent for a Method of working Pumps of various Descriptions by Machinery, whereby much manual Labour will be spared. Dated November* 1805.

Mr. Wyke's "*invention*" consists of capstan bars to give motion, by means of human or animal energy, to a vertical shaft, on which is a horizontal wheel, whose teeth drive those of a vertical wheel fixed to the horizontal axis that carries either the wheel of a chain-pump, or the cranks that work the piston rods of two, three, or more, sucking, lifting, or forcing pumps.

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*Observation.*—If the old maxim be admitted, that "*names* do not alter *things*," as we suppose it must, we shall then be free to say, that Mr. Wyke's specification exhibits no invention at all, or at least no invention but what was known before mechanics were formed into a science, and almost as long as there have been machines.

We expect soon to hear of a patent to secure the right of asserting, that 2 and 3 make 5 : and if Mr. Wyke do not find the present attempt succeed, we would beg to recommend that to his notice.

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*Mr.* Isaiah Birt's *Patent for a Black Paint, composed chiefly of earthy and mineral Substance. Dated September* 1806.—*Rep. Arts,* No. 55.

The receipt for making this paint contained in the specification is as follows: "Take of the blueish marly stone found in copper, tin, and lead mines (principally in copper-mines), and of iron stone, and of fine blue marble or slate, and of *under-earth,* equal quantities, and reduce them to a fine powder by grinding. To any quantity of these materials add one eighth of lamp-black." The whole is then to be mixed with drying oil, and ground together in the manner usual by colourmen. The patentee also states, that any two or more of the above articles, mentioned to be mixed with the lamp-black, may be used to produce a black paint, by grinding and mixing them with an eighth of lamp-black. He mentions, that the article he calls under-earth is to be procured from the coal-pits in the forest of Dean, and is generally called by that name by the colliers there; and that the blueish marly stone is produced in abundance in the mines of Devon and Cornwall. The quantity of the lamp-black mentioned is that which is generally preferred; but more or less has been used with good effect.

The title of the patent states this black paint to be particularly applicable to the use of the navy and shipping in general; and to be peculiarly calculated to preserve wood, and prevent rust in iron.

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*Observations.*—The patentee has not favoured the public with any reasons why his paint should be particularly applicable to shipping, and to the preservation of wood and iron : we therefore may be pardoned if we cannot discover them : indeed, on the contrary, we are of opinion, that from the sulphurous nature of the black substance he calls *under-earth,* procured from coal-works, it would be most likely very injurious to iron. The ingredients added to the lamp-black are all likely to diminish the colour, or make it brown rather than black; and not one of them possesses any drying quality, or other peculiar advantage, which may compensate for this defect. The great defect of the usual materials of black paint, is the slowness with which they dry; to remedy which, red or white lead, and other driers, are mixed with them : some cheaper substance having the same property might be a beneficial addition; but those mentioned appear to us to have no other use but to adulterate the lamp-black.

*Specification of Mr.* Richard Tomkinson's *Patent for an Apparatus for making and preparing white Salt. Dated July* 1806.—*Repert. Arts,* No. 53, *New Series.*

The chief object of Mr. Tomkinson's invention is to prepare salt without the use of iron pans: his pans are made of wood, brick, or tile, and the heat is conveyed to the brine in them by iron flues passing through the body of the liquor: those pans are directed to be made 50 feet long, 14 wide, and 15 inches deep at the edges, and $3\frac{1}{2}$ feet in the middle, and will thus contain a deep channel from end to end in which the iron pipe is to be placed, at such a distance from the bottom as to admit a scraper to pass between it and the bottom, and so that its top may be 15 inches lower than the upper edge of the pan: an iron cylinder, containing the fireplace, and communicating with the pipe, passes through one end of the pan, so that the fire may lie within the pan; the joints between the cylinder and the end of the pan are made tight with oakum.

The cylinder for the fireplace is to be made of cast-iron 7 feet long and $2\frac{1}{4}$ feet deep. The grate for the fire must not approach the entrance of the cylinder nearer than 6 inches, that the end of the pan, if of wood, may not be damaged. The pipe may be in as many joints as are thought fit; its farther extremity passes through the other end of the pan, where it is inserted into the chimney.

The patentee does not limit the number or size of pipes, or the dimensions of pans to be used.

*Observations.*—We apprehend that brick or tiles would not do for pans, unless so well glazed as that the vitriolic salts formed in the bittern should have no action upon them, as otherwise they would corrode and destroy them: there is some danger of the marine acid of the salt having some action on them also: wooden pans would be free from these objections.

*Mr.* James Plucknett's *Patent for a Machine for dibbling and drilling all Kind of Grain and Pulse. Dated April* 1806.—*Rep. Arts,* No. 53, *New Series.*

The patentee assumes in his introduction that dibbling is the only effectual way of sowing corn in order to ensure crops and save seed, which is a position much less generally admitted than he supposes; for on stiff and clay soils it has been found almost impossible to cover the seed by this method. The specification of

the machine then follows, which is so obscure and so inaccurately worded, that we confess our utter inability to comprehend the descriptions he has there inserted. This might have arisen from the imperfection of our judgment, and therefore we embraced an opportunity of examining the machine itself, and our readers will judge of our surprise by their own, when we assure them, that what is called in the specification, "*a hollow cylinder*, with an axle through the centre," is really nothing more than two wheels fixed at the extremities of an axle in the common method; and that what are there called "bars of iron placed all round the circumference of the *roller* about six inches asunder," are stumps of iron projecting an inch or two from the wheels at the circumference, to prevent them from sinking too deep in loose soils; and even these are entirely laid aside in those machines intended to be worked by a horse. The *description* of the hopper and the mode of delivering the seed is to us perfectly unintelligible; but some ingenuity and novelty of contrivance is displayed in a mode of shifting a cylinder, which closes the bottom of the hopper, backwards and forwards, by means of a wheel and escapement movement, aided by a brush to clear the cylinder of any corn which may not have been received into the recess formed to contain the proper quantity. None of these parts, however, though very essential, are noticed at all in the specification.

The machine made by Mr. Plucknett has much merit, and will be found useful in many instances for dibbling corn or beans; but we do not think it admits of being applied to turnips or clover seeds, unless the delivering segment and the bottom of the hopper were made of metal so nicely adjusted as not to admit of the seeds passing between the parts, which can scarcely be effected in wood: but the description of it in the specification is, in our opinion, so far from the clear description which we understand the law to require as necessary to support an exclusive right, that we doubt whether any workman of common understanding, and accustomed to similar work, would be able to construct a machine from the specification alone, after the expiration of the patent. The specification itself will be found by those who wish to refer to it in the Repertory of Arts, No. 53, of the New Series.

Several other methods of delivering the seed are described in the specification, besides that mentioned above, and it is directed that a number of hoppers and coulters be so placed as to work together, if the machine be made to be worked by a horse. In some of the machines a contrivance is described of forcing the coulter a small way into the ground at intervals, and drawing it up again with the intention of making holes, into which the seed might fall; but it is demonstrable that such a machine, when moved regularly forward, would not form holes at intervals, as the patentee supposes, but a drill varying in depth in a serpentine line, if the coulter were forced down gradually; and if it were sud-

denly forced down and retracted, then angular or semicircular cavities would be formed instead of holes, and great danger would be incurred of breaking the coulter, or some other parts of the machine, every time it was forced into the ground.

It is a question for practical agriculturists to determine, whether dropping the seeds at regular intervals, as performed by the machine, will have the same effect as dibbling in the common mode: we cannot see any reason why it should not do so; and it will certainly have the advantage over the common method, because it will uniformly deposit the grain at regular depths; which late experiments (made by Mr. Wright by order of the Board of Agriculture) have shewn to be an object of great importance, and have clearly ascertained that great depths are injurious to the produce.

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# AGRICULTURE.

*An Essay on Manures. By* ARTHUR YOUNG, *Esq.—Bath Papers*, vol. x.

THIS essay obtained the reward of the first BEDFORDEAN MEDAL, which was voted by the Bath Agricultural Society to the author who produced "the best essay, founded on practical experience, on the nature and properties of manures, and the mode of preparing and applying them to various soils: in which essay shall be pointed out the cheapest manner of collecting and preparing the different kinds of manures, and the state, season, and quantity in which they should be applied." In this essay the author considers the subject of manures under the several heads of their *nature*, their *properties*, the mode of *collecting* them, the *state in which they are applied*, the manner of *application*, the *season* when applied, the *quantity* required, and *on what soils* the respective kinds are most beneficial. In classing the various bodies which may be applied as manures, he divides them into,

1. Such as are dry or made on a farm; and,
2. Such as are usually purchased.

MARLE, of the manures of the first class, is the most common in England, in some one of the denominations of clay, stone, or shell marle; it may be distinguished by various colours, but these are no otherwise material than as indicative of iron. It is by *nature* a fossil substance, usually composed of sand, clay, and calcareous earth; it falls in pure water, as well as by exposition to the atmosphere. The *property* that renders this manure particularly

valuable is the calcareous earth it contains; and there is great reason to believe that the calcareous earth is the part taken up by vegetables. The common way of *collecting* marle is by digging: it may, however, be sometimes dredged up from the bottoms of rivers, particularly the Shannon. In searching for marle, therefore, these places ought not to be overlooked, but should be bored as well as other parts of a farm. This manure requires no *preparation*, and, as to *the state in which it is applied*, whatever benefit may result from exposition to the atmosphere, it must be attained after spreading; if, however, it be obtained from the bottom of lakes or rivers, the heaps should be left for six or twelve months. The *application* requires more extensive notice: the bulk of this manure renders the carriage so expensive that every means should be used for lessening it. As marle should be very long exposed for the atmosphere to melt it down, and as the roots of the grass combine it with the surface of sweard land, whether applied to this or to arable, it should be applied in such a manner as to remain as long as possible undisturbed. The most experienced farmers are apprehensive of turning marle in too deep with the plough. This manure is usually applied on so large a scale as to preclude choice in the *season*; it must be done when the teams have most leisure; it should, however, be suspended whenever the ground is much cut by the carting. The most advantageous *quantity*, though an object of extreme importance, has not been satisfactorily ascertained: it is better, however, to lay on too little than too much, as the application may be repeated in the former case; and the latter is sometimes productive of deterioration of the soil, and must be regulated in some manner according to *what soil* it be applied. On loose and sandy soils, the Norfolk farmers frequently apply from one hundred to one hundred and fifty cubical yards to an acre, and on soils of more firmness eighty, and even sixty yards have been found sufficient. If turnips produce deformed strings of root, or if the rush-rooted grasses prevail, the experienced farmer will pronounce the land to want marling; and upon wet loose loams, which are found when manured with dung to be more productive of straw than corn, marle has generally been found an effectual remedy.

Chalk differs so very little from marle as to make it necessary to point out only the variations: it *naturally* possesses more calcareous earth, and is comparatively harder, and consequently its *properties* are not very different: it is usually *collected* by digging from pits, which for the convenience of *application* should be opened at small distances; and it may be *applied in all states*, and at *all seasons*. The *quantity* required is smaller than that of marle, and the *soils* abounding with wild sorrel have been found to be highly improved by it; and indeed it is used successfully on all soils, on which marle has been found to answer: on moors, peat-

bogs, and peat-fens, chalk is more beneficial than marle, as containing a larger proportion of calcareous earth.

Lime has furnished matter for volumes; but the best chance of obtaining the plain truth will be, to reject opinions and examine experiment alone. Of the exact *nature* of lime, there is some difference among chemists: it may be obtained from the burning of all hard calcareous substances whatever, as marble, limestone, chalk, spar, &c. The operation of fire expels from these substances certain portions of water and carbonic acids, leaving nearly pure calcareous earth. From this circumstance its *properties* are sufficiently apparent, and are the same as those of chalk and marle as far as calcareous earth is concerned; it neutralizes acid salts, and consequently will act powerfully on all peat soils, but will not give the tenacity to sands, or the friability to clay, which chalk will effect: it is when slacked of such extraordinary divisibility that it is capable of much more intimate combination with other substances than either marle or chalk. It may be *collected* almost in every situation; for limestone exists in many districts unknown to the farmer: the common test of the stone is by pouring upon it a strong acid; yet this is not always practically correct. Calcination or burning is the *preparation* of lime, a process too common to need description. The *state in which* lime *is applied* is either fresh from the kiln while hot, or else after it is slacked; each method has its advocates: where putrefaction is the object of the *application*, it should be made as soon after it is burned as possible. Summer is undoubtedly the best *season* for the application of lime; but it may be laid on at other periods. The *quantity* of this manure varies more, perhaps, than in any other: it has been used up to seven hundred bushels to an acre, but the improvement has not been always in proportion to the quantity; for much depends on *the soil.* Upon peat-bogs and moors and mountains experience speaks an uniform language: on these the benefit of applying lime is great and decided; its caustic powers destroy the spontaneous productions of the soil, and convert them into a mucus, which the atmosphere turns into vegetable mould. All wastes are best reclaimed by lime. When Meriden Heath in Warwickshire was inclosed, part was trebly folded, part well dressed with rotten dung, and part limed: oats were sown over the whole: the part folded produced scarcely any corn, and the seed not worth saving: the part dunged succeeded very little better, but that which was limed produced an excellent crop. It does worst of all on a cold hungry soil, and on strong deep clay extremely retentive of moisture no perceptible good is produced by it.

Limestone has been tried and found excellent in ameliorating such soils as other calcareous manures operate upon successfully. The suffrages of Dr. Anderson and Lord Kaims are decidedly in its favour. When pulverized and reduced by breaking, it is not very dissimilar from lime which has been slacked; it is the best

of all manures for improving a bog, its great weight giving the pressure so much wanted on peat-moss.

CLAY, LOAM, and SAND, are substances which have been all used as manures upon the largest scale. Their effect depends on the deficiency of the soil. Clay is beneficial on sand, but sand not equally so on clay: what is called clay is sometimes found on examination to be loam, and always improves a sandy soil. Sea-sand, from the quantity of shells it contains, partakes of the nature of marle.

BURNT CLAY, MARLE, and EARTH, are frequently applied as manure in every part of the united kingdom. Their nature and properties will vary with the proportion of calcareous earth they contain, as that is converted by burning into lime.

PARING and BURNING are mechanical operations; and though nothing is directly added to the soil by them, yet the effects are frequently very beneficial. The *nature* of the ashes resulting from this operation must necessarily vary according to the nature of the earth burned; but in all cases the operation reduces the roots of vegetables to coals and ashes, and thus prepares a stimulant and nutriment for plants. The effect of heat in this operation is visible wherever burning has been practised by the spots where the fires were made assuming a deeper green that the rest of the field. The *properties* of the ashes may also vary with the soil, but they all operate as a very powerful manure: the practice of paring and burning has never been adopted without success. The common practice of *collecting* the turf is to pare on some soils from two inches thick to half an inch on others; but an inch may be considered the average depth; and the chief attention required in burning is to guard against too great a calcination. A considerable variation of the *state in which the ashes are applied* exists in common practice; some farmers spread and plough them in immediately; others leave them for a considerable time in heaps exposed to the atmosphere. In the *application* they should be kept as near the surface as possible, and care should be taken not to bury them very deep in the furrow; and as this work can only be done in dry weather, the *season* is necessarily limited to the summer months. The *quantity* of this manure must depend on the depth of paring, and on *moist soils* it may be applied with success: experiments have confirmed the beneficial effects of paring and burning on clay, loam, sand, chalk, and peat.

YARD and STABLE DUNG is the principal manure employed by ninety-nine farmers out of an hundred; but whether it should be accumulated in heaps till fermentation and putrefaction have brought it to a certain state in which it is most ready and proper for applying to the land, or whether it should be carried to the land before that fermentation and putrefaction take place, has excited much dissertation and inquiry. The late Mr. Ducket conceived that the more dunghills were stirred, the more their virtue

was lost. Mr. Patterson of Wimbledon, and Mr. Bocket of Hertfordshire, are of the same opinion. Mr. Johnson of Kingsthorpe near Northampton has for many years been in the practice of laying long dung merely wetted by his cattle on the land, and has found that the fresher it is used the better the effect. Mr. Robinson near Salisbury has been confirmed in this practice by a succession of superior crops, and the example of his more intelligent neighbours. Mr. Rogers of Ardleigh in Essex has found long dung preferable to short, not only for corn, but for turnips and potatoes; and a considerable number of the best agriculturists in Norfolk have adduced their experience in favour of the practice. Mr. England, Mr. Reeve, Mr. Dursgate, and several others, however, have relinquished the practice of using long dung, from a conviction that rotten is preferable in almost every respect. With regard to the *nature* of dung, all organized bodies are resolvable into hydrogen, nitrogen, oxygen, carbon, phosphorus, and sulphur; and the mixture of animal and vegetable matter, which is called dung, contains all these. The grand *property* of dung is to yield immediate food to plants: it opens the soil, if strong; it attracts moisture, and by the fermentation which it excites in the soil produces the decomposition of whatever vegetable particles may be already in the land; its effects have powerful progressive influences to produce a great crop of leaf, root, and stalk; and, by its shade and fermentation, leaves the land in better order for succeeding crops. The circumstances to be attended to in the *collecting* yard and stable dung in receptacles are few, but very important; the most material is the spreading over the yard a layer of earth or peat to receive the moisture from the dung, and prevent its being wasted. This manure requires no *preparation*; no stirring, mixing, or turning; but if the weather should occasion too much fermentation, it may be advantageous to scatter a quantity of the same earth over the surface as was made use of for the under-layer. As *to the state in which it is to be applied*, upon the principles detailed above, it is to be carried to the land as soon as circumstances of crops and convenience will permit. The *application* deserves attention; for all dung should be applied to hoeing crops, to layers, or to grass lands, and never to white corn; but this is more essential with fresh long dung than with that which is short, for there will be many more seeds of weeds remaining in it, which have not been destroyed by fermentation, and would consequently grow, and render the land foul. If the dung is turned in for any crop so early, that more tillage is to be given before sowing or planting, it should be ploughed in deep enough for the successive operations not to bring it nearer the surface; for all animal and vegetable manures have a constant tendency to rise, as fossil ones have to sink. The right *quantity* of dung must be found by experiment; but if it has been found to answer on any soil in a particular proportion, that proportion may be retained.

And as it is generally allowed that dung divides and loosens the constituent parts of *the soil* by fermentation, it is applicable to *all*; but it must necessarily have a more desirable effect on soils too compact than on others already too light.

The SHEEP-FOLD is a method of manuring which is universally known. The immediate application of dung and urine to all soils, and of treading to loose ones, is too generally practised to need recommendation. This circumstance may, perhaps, tend to elucidate the propriety of using yard dung, while it retains the greatest quantity of these valuable materials.

PIGEON'S DUNG is esteemed a very hot and powerful manure, and usually applied by measure; the common *quantity* is from forty to fifty bushels to the acre. No other kind of dung would produce the same effect, for no other kind contains an equal abundance of volatile salts.

POND and RIVER MUD are extremely uncertain in their effects. In several experiments the benefit has been extremely great; in others but little good has resulted from it. These different effects are easily reconciled; for in proportion as the water is resorted to by cattle, wild-fowl, &c. or receives the drainings of yards or towns, in that degree will the mud be good, and display its virtues.

SEA WEEDS are used with uniform success whenever they can be obtained. In different parts of the coast, however, they have been found to produce fertility for very different periods.

POND and RIVER WEEDS may be used with success before the last ploughing for turnips, and spreading them as a manure for that crop. Mr. Coke clears the lake at Holkham every year for this purpose. Mr. Wagstaff values them load for load as dung.

HEMP and FLAX WATER makes the grass grow doubly, where it is used as a manure in Yorkshire, which shews that all the putrid water of the pits should be used as manure. Mr. Billingsley carted flax water on his grass lands, and found the effect superior to that of urine.

BURNT VEGETABLES have a near resemblance to the ashes produced by paring and burning in their *nature*, *property*, and *effects*. A practice prevails in part of Lincolnshire of burning straw upon turnip land just before sowing: from three to five tons to an acre are laid on and evenly spread, and then set fire to; and it has been found superior to common dung.

PLOUGHING in GREEN CROPS is a mode of husbandry which has been long practised with satisfaction in this kingdom, and is common in many others. The practice keeps its ground, though the success be not uniform. If growing vegetables turned down prove good manure, it can only be from their fermentation converting them into the food of plants. Care should be taken that they be completely buried, as the effect depends much on

the execution. Ploughing in green crops answers better for a summer crop, as turnips or tares, than for autumnal or spring crops.

The second class of manures, or those which are usually purchased, the author divides into animal, vegetable, and fossil; and as this subdivision is not merely imaginary, the several substances are noticed in their respective orders, with observations common to each kind.

NIGHT SOIL is to be had in quantities only in the neighbourhood of cities. In such situations it is largely used, and much experience has arisen from the application. The common quantity for an acre is two hundred bushels. It is the best of all manures, and, if dry, the cheapest: it does well on all soils and for all crops. It has been drilled along with rape-cake dust with much benefit by Mr. Coke at Holkham.

BONES are used to a considerable extent about London; about five or six loads to the acre, which contain on an average two hundred and fifty bushels. They are most beneficial on strong soils, and their duration exceeds that of any other manure. The effects have been visible for more than thirty years. The dust and refuse of bone manufactories is also a valuable manure, particularly for drilling.

SHEEPS' TROTTERS are a powerful manure, and usually sold by the quarter with felt-mongers' cuttings: they are commonly applied in the proportion of four or five quarters to the acre, but eight are sometimes used. They should be ploughed in not less than six or eight inches deep, to prevent the attraction of vermin and dogs.

HAIR of hogs is sometimes sold in great cities; and from sixteen to twenty bushels is the quantity usually applied to an acre.

FEATHERS are found to be a powerful manure, and twenty-five bushels an acre have been spread with much success; ten bushels to an acre yielded a produce of forty-eight bushels of white wheat, while the same quantity unmanured produced only twenty-eight bushels.

FISH of all kinds is one of the most effective manures that can be carried into our fields. The whale-blubber offal never fails of producing great crops wherever it is applied; pilchards and herrings produce the same effect. In Dorsetshire Mr. Davis spread them fresh at one shilling per load, and ploughed them in for wheat with much benefit, but they are usually applied mixed with salt. In the fens the small fish called sticklebacks are obtained out of the rivers, and applied to this purpose.

GRAVES or tallow-chandlers' refuse is purchased for manure, and from ten to fifteen hundred weight are commonly spread upon an acre. The effects from them on poor sandy soils are very great in turnip crops.

Woollen rags, chopped in small pieces, are frequently applied as manure, from ten to fifteen hundred weight to the acre. It has been noticed in Hertfordshire that they are most beneficial on dry and sandy soils. They become the food of plants in common with all other animal substances, and also attract and retain much moisture from the atmosphere.

Curriers' shavings and furriers' clippings are bought in London and other populous places. When corn sells high they are eagerly sought for; for though they are an expensive, yet they are a beneficial manure, but do best on dry soils.

Horn shavings are also bought, and applied at about thirty bushels to the acre; they are applicable to all soils, but succeed best on all in wet seasons.

These manures are all animal substances, and their *nature* and *properties* are in all resolvable into the same parts as yard and stable dung; they contain the principles which by every consistent theory of vegetation are necessary to the food of plants, and the practice of the farmer is in perfect unison with the theory of the chemist; for every husbandman knows, or ought to know, that every animal matter whatever will fertilize his fields. The only question of *preparation* which can arise, is whether these substances should be immediately applied to the soil, or prepared by fermentation in a dunghill; and the common practice is to make the *application* of them to the soil *in the state in which they are purchased.* The *season* must be determined by the opportunity of purchase, and the *quantity* has been remarked under each article; and as to *soil,* all animal substances act as manures powerfully on all.

Wood ashes were found to be a manure in consequence of some experiments undertaken to disprove a suggestion of Mr. Hazenfratz, who thought that all alkalis were not manures. The *nature* of them is well known, and wherever they have been tried, they have proved a valuable manure. Their *property* is to attract carbonic acid from the air; they are *applied* without *preparation,* and the spring is the proper *season*; and forty bushels to the acre is the common *quantity* on all *soils.*

Peat ashes are a common manure in all countries where peat-bogs are found; their value usually depends on the blackness and density of the peat, and the neighbourhood of Newbury in Berkshire supplies the best: the usual *quantity* of these is ten or twelve bushels to the acre, but of other kinds from twenty to forty bushels have been used; their effect is greatest on dry friable soils.

Coal ashes are used all over the kingdom, from fifty to two hundred bushels to an acre; they are most effective when spread on clover, sainfoin, or other seeds, in the spring, and are beneficial on grass lands and green wheat. The effect on them is con-

siderable on the dry chalk lands of Hertfordshire. The knowledge of their *properties* is very imperfect.

Soot is composed of oil, volatile alkali, carbon, and earth; no wonder therefore that it should be found a very powerful manure. Its component parts are so minute that they may be washed into the ground by a single shower, and become the immediate food of plants. Twenty bushels to the acre is the most common *quantity*, and the *season* of application is the spring. Green wheat and clover are much benefited by this manure, the effect of which is great on *most soils*, but least upon strong or wet clay.

Peat dust, if the peat be black and solid, is resolvable into a greater proportion of hydrogen gas than most other manures; it is also strongly attractive of humidity, which renders it very advantageous on dry sandy *soils*. The use of it as a manure is not general, but it is well known, and much esteemed, in Bedfordshire and Hertfordshire.

Potash waste is a powerful manure; and ten loads, or three hundred and fifty bushels, are commonly applied to an acre. Much good is produced by it on low meadows, and in general on all grass lands.

Sugar-bakers' waste is supposed to be a powerful manure, but its effects are not known from experiment; it can be procured only at five or six places in the kingdom.

Tanners' bark, if useful any where, ought to be so on calcareous soils; mixed with lime it has been beneficial. But as the tanning principle is in all cases hostile to vegetation, whatever benefit is derived from tanners' bark must arise either from the lime or the animal impregnation. Experiments do not recommend it.

Malt dust has been used with success wherever it has been applied. Particular experiments have proved its value, if laid on from fifty to sixty bushels to the acre. It gives great improvement to cold grass lands, and is consistent with all kinds of *soil*.

Rape cake has been in common use in Norfolk for more than half a century, and the quantity was usually half a ton to the acre; an advance of price has however now compelled the agriculturist to lessen the quantity, and Mr. Coke makes a ton do for five or six acres by drilling it with turnip seed. When ploughed in with wheat, it has been found more forcing to the crop than either dung or fold; but the turnips after the wheat have not been so good as after those manures. Malt dust and soot were found equal for wheat, but rape dust better than either. The operation of this manure is assignable to a very obvious theory; for all oleaginous bodies abound greatly with hydrogen and carbon, and their utility consequently must be great.

These manures are all vegetable substances, and their *nature* and *properties* do not differ from the vegetable substances in the first class; the most beneficial *quantity* has been mentioned under each.

Among fossil manures coal ashes might have been classed, but for obvious reasons they are mentioned with other ashes: lime has also been treated of in the first part of the essay; there only then remain to be noticed salt and gypsum.

SALT by various experiments and by observations made apparently with care, has been decided to act as a manure in some cases to a degree that proves its excellence, when properly applied, but other persons have reported unfavourably of it. The knowledge of this manure is yet in its infancy, but experiments have generally shewn it to be beneficial, but more especially when added to any dung or dunghills; and it probably acts as an assistant to putrefaction.

GYPSUM is scarcely known at all as a manure: the reports of those who have made experiments with it are very contradictory. In this state of our knowledge both of this and the preceding article it is wise to accept the favourable reports, and attribute the failures to soil, season, or some unrelated circumstance. The *quantity* of gypsum usually applied has been about six bushels to the acre.

Experiments on mixtures, or COMPOSTS, are extremely difficult, and must be ever unsatisfactory. If composts be resorted to to promote putrefaction, that is inconsistent with the idea that putrefaction should be retarded till the manure be applied to the land; they may be useful to get rid of an evil, as to mix potash, or lime, or chalk, with pond mud to destroy its sterility; but here seems to end the benefit of composts.

THE FOOD OF PLANTS deserves much consideration in the application of manures. From experiments extremely numerous, and observations made by eminent chemists, it appears that the two substances which play the greatest part in vegetation are hydrogen and carbon (the presence of light and heat is always to be supposed): those manures then which supply the greatest proportion of these, must be most beneficial in promoting vegetation. Theory has furnished many conjectures on this subject, but experience has confirmed few facts; and the inquiry belongs rather to chemistry than to agriculture.

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*Observations.*—The great length of this essay has obliged us to dedicate so many pages to an account of its contents, as to preclude the possibility of many observations. Mr. Young has certainly treated his subject with much perspicuity of arrangement, but has frequently omitted some of the qualities of many of the different kinds of manure. Of the gentlemen who are said to have reported experiments, many are not sufficiently identified to be traced out, and resorted to in case of a wish for more accurate information. From the situation which Mr. Young has so long held of Secretary to the Board of Agriculture, and the number of years he has been favoured with the correspondence of agri-

culturists, as the publisher of the Annals, he possessed sources of information to which very few other men could have access: he has certainly done much towards elucidating the difficult subject of manures; but much remains yet to be accomplished. The peculiar form of the essay precludes criticism; for it is little more than a table of contents; its divisions however are all preserved in the preceding article, which will be found to convey the spirit of the original. The prices of the different manures have been uniformly omitted, and we think they ought not to have been introduced into the essay itself. Many of the facts adduced by Mr. Young are almost of ancient date, as appears by the reference to volumes of the Annals published nearly twenty years ago. In a composition embracing so many different points, perfection was not to be expected; but we consider the execution inadequate to the means of information, which Mr. Young exclusively possessed. As none of the other candidates for the medal have published their essays, comparison is not allowed us; but we can see many reasons why they may have been inferior. The production under consideration, notwithstanding its defects, may certainly be considered as the first of the kind in importance, which has been submitted to the press in this, and, as far as we know, in any other country; for it contains more fact and less speculation than any other essay on the same subject. We recommend it to our readers, if not as a guide for their practice, at least as furnishing many useful hints for the prosecution of their inquiries in a very important branch of agricultural economy.

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*On Mildew, in Reply to several Queries on the Subject.—Young's Annals,* No. 261.

Mr. William Custance, of Cambridge, observes, that soils of all kinds have been equally affected in particular situations; that late sown crops have suffered most; that thin crops have escaped best; that the greatest mildews happen after mild winters; that the land which has been best done by and most manured has been most affected; and that the barberry has no particular influence in affecting wheat in places near to it. He believes early cutting to be the most likely means of preserving the grain from being affected.

Z. Y. of Barnsley thinks that lands, which have a substratum of limestone, or soil bordering on limestone, are most affected by mildew; that blight, mildew, and honey-falls, are scarcely possible to be distinguished from each other; that these have not their dependance on situation so much as soil; that neither thick nor thin sown, but middle crops, escape best; that old seed is preferable to new; and that dews dropping from barberry, owing to its very acid quality, may injure wheat growing

under it, but that the atmospheric air issuing from it cannot be injurious at any great distance. He thinks that cutting as soon as the straw becomes dead either at top or bottom, and binding up in sheaf, gives more time for the small quantity of sap remaining in the straw to mature the head, than if exposed to the sun and not cut early.

Mr. Joshua Musket, of Easton in Norfolk, is persuaded that very little can be done to guard against the mildew, as he has no doubt that the cause is atmospheric; he thinks that late sown wheats, and low lands, and small wood-bound enclosures, suffer most, and that thick wheat has always escaped best; that new or old seed makes no difference; that crops on fallows have escaped best; and that the barberry bush certainly attracts mildew, as the wheat is always most affected near it. He believes early cutting to be useful, and that as soon as the milk becomes soft like paste it may be cut with safety.

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*Observations.*—The opinions of these practical agriculturists are too much at variance to draw any general conclusions from. Whatever may be the power of the barberry in attracting mildew, it is not reasonable to suppose it can operate at any considerable distance. That the free circulation of the air is of importance in preventing mildew is evident, from its being found so much more frequently in small enclosures than in open fields. The causes of the disease remain yet to be explored; but the best method of confining its effects is to cut the wheat as soon as possible after it is affected; for it never improves afterwards.

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*A never-failing Mode of preventing the Destruction of Turnips by the Devastation of the Fly, or Insect so called. By Sir* John J. W. Jervis, *of Ireland.—Young's Annals,* No. 261.

Sir John Jervis had conceived that the all-devouring insect which destroyed turnips was generated either from ova or from animalculæ, and that as sulphur had been long known to destroy those animalculæ which were discoverable on persons who were tormented with the itch, it would, if applied to the root of the evil, operate equally successfully on the fly, which so frequently occasions losses and disappointments to the farmer. Accordingly he mixed flour of sulphur, in no great quantity, with turnip seed, and sowed it in a field near a wood on his demesne of Belcamp, in the county of Dublin, where the fly had always been troublesome and destructive. He found that the turnip was *perfectly safe* and *free from any fly*. He did so again, and found the same effect. He is convinced that dressing turnip seed with sulphur will *always* preserve it from the fly; and he thinks the cheapest mode of instilling the sulphur would be by steeping the seed in

sulphur water. Sir John Jervis fancied he smelled the flavour of the sulphur on the turnip leaf; but so strong an impregnation he should not deem necessary when imparting a sufficient quantity to kill the fly.

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*Observations.*—This communication of Sir John Jervis is of great importance to the agricultural world. The inconvenience arising from the fly destroying the turnip crops is most severely felt by those farmers and breeders, who rely on turnips for the winter food of their cattle, and no certain preventive or remedy had been before known. It is certainly desirable that the success mentioned in the communication should be confirmed by more experiments in different parts of the United Kingdom, and there can be no doubt but they will be universally tried. The analogy of reasoning which led to the experiment was conducted by the soundest judgment; and the unaffected modesty with which the communication has been made known to the public, must induce that public to entertain a very favourable opinion of the gentleman, to whom agriculturists are so much indebted for this most important information.

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*On the Employment of Bulls for working Ploughs.*—*By Captain* Studd.—*Young's Annals*, No. 261.

The Captain has worked bulls at the plough instead of oxen for more than twelve months, and has found them do more work. He ties them up for a short time to enable the men to handle them, after which they are harnessed in the common harness used for horses, the collars and seals being made larger and wider to fit. The animal is then fixed to a large log of wood at the end of a chain, or placed in the middle of a team, and broke in like a colt. The method he adopts for shoeing them is new and curious. The animal is slung up by a long lever frame, upon a piece of sacking which goes under the belly, and is fixed to the frame by chains from the four corners, and the shoes are fixed while he remains suspended from the ground.

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*Observations.*—As bulls cost much less to keep than horses, and are much more powerful than oxen, the more general introduction of them for agricultural purposes would be attended with beneficial effects. The mode of shoeing described in this article is deserving of general imitation, and ought to be applied to oxen. Many inconveniences and frequent injuries attend the usual mode of casting oxen for shoeing, which would all be obviated by slinging them up in a lever frame in the manner described in this communication.

*On the Diseases of Calves.* By AGRICOLA BAMFFIENSIS.—*Farmer's Mag.* No. 28.

THIS communication was occasioned by the publication of Mr. Sitwell's cure for the navel-ill in calves, which was noticed in the last number of the Retrospect. The agriculturist who makes it, states that the disease above alluded to may always be prevented by cutting with a pair of scissars the navel-string of a calf, as soon as it is calved, about half an inch from the navel. For as the disease is the consequence of inflammation, and that inflammation is brought on by the exposure of such a length of *raw* substance to the action of the air, by the operation recommended the cause of inflammation is removed, and consequently the disease is prevented.

*Observations.*—This operation is always performed by accoucheurs on the human subject for the same reasons, and the analogy of nature equally points out the same means to be applied to the brute creation. The same motives of general utility which induced us to speak well of Mr. Sitwell's remedy for this complaint in our last number, operate still more forcibly with us to recommend to notice the preventive operation practised by Agricola Bamffiensis.

*Receipt for the Foot-rot in Sheep.—Farmer's Mag.* No. 28.

AFTER the foot has been made perfectly clean, and the hoof pared down to the sore, the gentleman who made the communication, recommends that it be anointed with a mixture of tar, salt, and black soap, in equal quantities, and afterwards touched with a few drops of vitriol, which will then run into the wound. He adds, that it will be necessary to keep the sheep either in the house, or on dry ground, for a day or two.

*Observations.*—Though this receipt may be now given to the public for the first time, it has been long used with success in the counties bordering on the fens, where, from the wetness of the soil, the foot-rot more particularly prevails. It is very material to prevent the sheep from going in the grass for a considerable time after dressing, as the dews and other moisture will combine with the oil of vitriol, and entirely burn away the foot instead of producing a cure. This effect cannot take place without a combination of the vitriol with water.

*On Free Martins.—Farmer's Mag.* No. 28.

When a cow produces twin calves of different sexes, the female is called a *free martin*, and is generally esteemed incapable of propagation. This opinion has obtained from the universality of their never courting the addresses of the male, and from some of them having been found on dissection not to possess the uterus. This paper is no otherwise interesting than as recording an instance of a free martin producing a calf. She was the property of Mr. Buchan, of Killingtringan, in Ayrshire. The editor of the Magazine has printed the paper, without considering himself responsible for the curious circumstance detailed in it. For as the not breeding of a free martin is a departure from the general law of nature, that every individual shall be capable of propagating its kind, so the solitary instance of Mr. Buchan's free martin having bred, may be a departure from the common property of free martins.

*Observation.*—Though this communication does not rest on undoubted authority, yet we have noticed it, rather for the consideration than the information of our readers.

*On mowing Wheat, and on the Quality of stored Roots. By Mr.* Brightley.—*Agric. Mag. New Series,* No. 5.

It is observed in this communication, that the practice of mowing wheat is more general than formerly, but no peculiar benefit is stated to result from it. The practice is at best a slovenly one; and if straw be the only object, that would be best attained by mowing the stubble afterwards, which would permit the crop to be carted home in less time at a very critical period of the harvest than if the whole were mown; and it would be impossible to collect the corn with so little waste as if the usual mode of reaping it were adhered to: the bundles if mown would be much more unmanageable than the sheaves are which are made from reaped wheat.

The quality of turnips is said to be much improved by storing them through the winter, and giving them to the sheep in the spring; for by undergoing in the stack the sweat, which is common to all vegetables when laid in heaps, they become more strengthening and nutritive to the stock, than in their fresh and watery state, in which it is well known they often purge and disagree with sheep, and not unfrequently occasion the red water,

*Observations.*—The mowing of wheat will never become the common practice of farmers who wish to employ their labourers

to the most advantage in the time of harvest; for more time is lost in the carting the additional quantity of straw, than is gained by using the scythe instead of the sickle. Besides this, the waste is much more considerable.—As to the benefit to be derived from storing turnips, it may reasonably be expected; for apples and carrots become more wholesome from undergoing that perspiration, which is the inevitable consequence of their being laid in heaps, and analogy of reasoning will extend the same principle to turnips.

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*Wintering and Sale of Sheep, Culture of Cabbages, Rutabaga, &c.—Agric. Mag. New Series,* No. 5.

This communication from a Hertfordshire farmer, gives an account of the benefit he derived from burning wheat stubble, weeds, and some of the soil on a cold harsh clay of considerable depth, which had been cropped out of all heart, and was covered with weeds like a mat; and of the profit he derived from a flock of the pure unmixed breed of Lincoln sheep. He bought them early in the spring, fed them in a coarse pasture through the summer, gave them oat straw in the first part of the winter, and afterwards rye grass hay, cabbages and kail, and peas in the haulm, cut from the stack in the same manner as hay. They soon became fat, and returned a considerable profit. The land where the stubble and weeds had been burned on the ground produced an unusually luxuriant crop of cabbages, kail, and rutabaga, or Swedish turnip, a part of it being appropriated to each.

*Observations.*—The feeding sheep with peas in the straw is certainly a new idea, and as far as can be collected from the imperfect manner in which the account is related, deserves to be attended to in future experiments. The burning the weeds, stubble, &c. with the adhering clods, after they have been turned by the plough, is only a less perfect, though a less expensive mode of paring and burning than that usually practised.

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*Comparative Experiment in the Culture of Wheat, made with a View to ascertain the Effects of different Modes of preparing the Seed.—Agricultural Magazine.* No. 4, *New Series.*

This communication by *Agricola Northumbriensis,* contains the result of fourteen experiments on wheat differently prepared, which was dibbled in that number of rows on the 7th April 1806, without any variation of weather. In the first row perfectly clean seed was dibbled without any preparation, and the produce

was 314 ears, and none of them smutted. In the second row the same kind of wheat was used, after being blacked with the powder of smut balls, and pickled with lime and salt water, and the produce was 281 ears, of which twenty-four were smutted. In the third row the same kind of seed was used, after being blacked and pickled with old chamber-lye and lime, and the produce was 203 ears, of which five were smutted. In the fourth row the same seed was used quite clean, and pickled with chamber-lye and quick lime, and the produce was 231 ears, and all of them were free from smut. In the fifth row the same seed was used clean, and pickled with salt water and lime, and the produce was 243 ears, none of which were smutted. In the sixth row the same seed was also used clean, and prepared with chamber-lye only, and the produce was 217 ears, and none of them were smutted. In the seventh row the same seed was also used clean, and prepared with salt water only, and the produce was 250 ears, of which none were smutted. In the eighth row the same seed was used clean and without any preparation, and the produce was 188 ears, and all clean. In the ninth row the same seed was also used clean, and washed in common water, and the produce was 250 ears, and none of them were smutted. In the tenth row the same seed was used blacked with the powder of smut-balls, and sown in that state without pickling, and the produce was 247 ears, of which 140 were smutted. In the eleventh row the same seed was used blacked as in the last row, and prepared with lime and common water, and the produce was 314 ears, of which 22 were smutted. In the twelfth row the same seed was used blacked as before, and sown without pickling or any preparation, and the produce was 196 ears, and 90 of these were smutted. In the thirteenth row the same seed was sown clean, and without any preparation, and the produce was 300 ears, none of which were smutted. In the fourteenth row twelve small, very small, shrivelled grains were dibbled; they were very light, and skimmed off the water in which the good wheat had been immersed; of these 9 vegetated and produced 90 sound ears, and 3 smutted ones. The attention of the reader is called to the *quality* of the produce only, as the *quantity* dibbled into the rows varied greatly. The trial was made in the middle of a large field of spring wheat, and the experiment conducted with the greatest accuracy.

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*Observations.*—These experiments convey much less practical information than might have been expected from the number of them: three were made with wheat in the same state of cleanness without any preparation, and the result was nearly similar. It may be collected, that if the corn be itself free from smut, it may be safely sown without any pickling, and that pure water is nearly if not quite as good a preparation as can be used: this is sufficient to cause the light grains to rise to the top, that they

may be skimmed off; for the last experiment shews them to be productive in a very small degree, if at all; and the most powerful pickle was not sufficient to extirpate the smut from that corn which had been previously blackened with it. Intelligent agriculturists have long held that no farther preparation was necessary for seed wheat, than to wash it well in abundance of pure water, and skim off the grains which rose to the surface; and the experiments in this article tend to confirm this generally received opinion, but establish no new facts whatever.

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*One fine-woolled Sheep being most subject to the Foot-rot, and some Account of the Spanish Ram imported into Northumberland.* —*Agricultural Mag.* No. 5, *New Series.*

The only fact contained in this article is, that some Anglo-Spanish lambs (from South-Down ewes), which were weaned with a large flock of new Leicesters and South-Downs, suffered much more from the foot-rot, and foot-halt, than the other breeds. They had not been more than nine or ten days on the lamb pasture, before most of them were lame, while the new Leicesters almost wholly escaped the disease. The description of the ram does not distinguish it from others which have been imported: the fleece was comparatively heavy, for it weighed five pounds three ounces.

*Observations.*—This communication, which bears only a feigned signature, is merely deserving of notice as containing a fact which is easily accounted for on theoretical principles. For the shepherds of Spain regularly drive their flocks in the winter months from the mountainous districts into Estremadura, because they are there less affected by disease on account of the dryness of the soil. The mountainous parts of Northumberland are equally wet with the most steep of the Segovian hills in Spain, and the flint stones are alike sharp on both.

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*On the Figure in which Trees should be disposed in Plantations.* *By* Philo-Hexagon.—*Farmer's Mag.* No. 28.

The writer declares the object of his communication to be the promoting utility, not an inquiry into beauty. Whatever pretensions the *irregularly regular* manner of Mr. Loudon, or the *quincunx* form of Mr. Nicol, may have to beauty, he contends that they are insufficient in point of utility. He considers it by no means an useless inquiry to make, What is the natural disposition of trees in a forest? For he receives it as a general maxim, that Nature endeavours to attain her ends by the best possible

means, though extraneous causes may sometimes derange her operations. Considering those causes which may contribute to the disposing of trees in a forest in a particular form, and abstracting the influence which the wind may have in confusedly scattering the seeds, the following proposition appears to him extremely probable: "*That mature strong trees, which have arisen from the seed of any one tree, will be found nearly in the angles of an equilateral and equiangular hexagon, with the original tree in the centre.*" For though few trees may form an exact circle by the extremities of their branches, yet all will be found to approximate to that shape. The tree will scatter its seeds as it attains its growth and its branches extend, and many plants will spring up upon or near this circumference; but as all these cannot be supposed to flourish for any length of time, it is reasonable to conclude that those will prevail over their weaker neighbours, which are equally distant from the parent tree, and from each other; and these points can only be found in the angles of an equilateral hexagon. The same supposition may be extended to the decay of the parent tree, and to new plants springing up in a similar form round each of the six trees which composed the first hexagon, and so on, till in this way a forest may be formed. This then appears to be the form in which unassisted nature would for the most part dispose of trees in a forest; and the writer considers the fact to be established from the preceding reasons. He then proceeds to shew, that "*The closest order in which it is possible to place a number of points upon a plane surface, not nearer than a given distance from each other, is the angles of hexagons, with a point in the centre of each hexagon.*" For a hexagon with a point in the centre has this property, that each of the angles is at an equal distance from the two angles on each side of it, and also from the central point (*see Euclid, book 4, prop.* 15); and it may easily be demonstrated, that no other regular figure has this property. The writer remarks, that if any one take seven shillings, and place one of them in the middle and the others round it, he will find the whole space round the middle shilling completely filled up, without vacant space being left, or the pieces lying one on another, which cannot be effected by a greater or a smaller number. To prove that this disposition will contain a greater number of trees than any other, he resorts to a variety of simple calculations of the trees contained in a square piece of ground in rows of various kinds, where an equal distance is preserved between each, which are too obvious to need repeating: and concludes by shewing, that 115 trees planted in this way at 5 feet distances would occupy no more land than 100 trees planted at the angles of a square.

But as common workmen may not know how to plant trees in the manner recommended, he gives the following directions: "Take a line and two staffs, the one five feet long, and the other

four feet four inches; and with the line set off rows four feet four inches asunder by the shorter staff, and plant the trees five feet asunder in the rows by the longer staff, observing the first tree in the second row be exactly opposite the middle of the space between the first and second tree in the first row; and so on with every succeeding row till the ground be planted." This is the proportion for a five feet distance; and the following table is added of the length of the short staff corresponding to different lengths of the long staff:

| " Long Staff. | Short Staff. |
|---|---|
| 3 feet, 6 inches. - - | 3 feet, 0.372 inches. |
| 4 feet. - - - - - - | 3 feet, 5.568 inches. |
| 4 feet, 6 inches. - - | 3 feet, 10.764 inches. |
| 5 feet. - - - - - - | 4 feet, 4 inches. |
| 5 feet, 6 inches. - - | 4 feet, 9.156 inches. |
| 6 feet. - - - - - - | 5 feet, 2.352 inches." |

This table will enable any workman to plant trees in the hexagonal form, from 3 feet 6 inches to 6 feet distance between them.

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*Observations.*—Our mathematical readers will perceive at the first view the advantage of planting trees in the form recommended, and the mode of ascertaining the distance of the rows; for a pile of hexagons is nothing more than a repeated series of equilateral triangles, placed with the base alternately upwards and downwards, and the distance of the rows is equal to the perpendicular height of an equilateral triangle. The superiority of this mode of disposing of trees over planting them in squares is so apparent as hardly to deserve notice; for in the latter mode they cannot be all placed at equal distances from one another, and the same applies to the quincunx form, which may be used only in clumps; and as to the irregularity of distance so strongly recommended by Mr. Loudon, if the nearest trees be sufficiently distant from each other to promote their growth, many must be placed at greater distances than is necessary, and consequently much room must be lost. If this paper had been merely a record of facts, we should have considered it less deserving of notice, from the writer having concealed his real name under the signature of Philo-Hexagon; but when a position depends only on mathematical reasoning, and may be borne out by plain and obvious demonstration, it is equally important, notwithstanding it is anonymous. The paper before us is of this nature, and the method of planting described in it carries in its own intrinsic merit the most powerful recommendation.

*Instance of preserving a Tree nearly barked.—Farmer's Mag.* No. 28.

A WILLOW and an elm of considerable size were nearly barked by a cow about six feet from the ground in 1804; there was however left remaining in each case a small fillet or riband of bark, in width about one fifth part of the circumference of the tree, which, though torn away from the stem, remained attached to the bark above and below. This fillet of bark was again bound close to the stem of the tree by a cord entwined round the trees. They both lived and flourished as vigorously as before. The fillet of bark of the elm adhered again to the tree, and a new coat of bark was formed under it; the bark of the willow did not adhere, but new wood was formed under the bark, which in time will probably become both trunk and bark, and the old trunk will entirely rot away.

*Observations.*—It is a well-known fact, that a tree which loses its bark must infallibly die; for the uninterrupted connexion of the bark is necessary for the circulation of the fluids from the root to the extremity of the branches; if, however, a part only be torn away, the remainder will extend itself from the lips of the wound, and in time grow over the part which had been laid naked. In the cases under consideration the effect was accelerated by the binding keeping off the air. It is evident from the experiments of Mr. Forsyth and others, that all wounds on trees will heal if protected from the external air, and mere binding with a cord seems to have produced an equal effect with the boasted medicaments of His Majesty's gardener at Kew.

*On Sheep-smearing. By* S. L. A.—*Farmer's Mag.* No. 28.

THIS communication is in reply to a letter in a former number, and asserts, that smearing keeps sheep warm and dry during the excessive sleets and rains of winter. He is of opinion that tar and butter, which are the principal ingredients used, being of an unctuous and oily nature, resist the rain in the same manner as the feathers of water-fowls, who continue dry while swimming on their native element. He thinks also that the wool is improved by this practice; for as every pile of it is anointed with this unguent, and as the wool grows in a hanging position, it is less liable to be injured by the wet remaining on it, for the unctuous substance will accelerate the passing off of the rain. He has no doubt but that the quantity of the wool is increased in a

considerable degree, as well as being rendered finer; for the heat of the animal liquefies the salve, and the oily part of it slowly makes its way into the pores of the wool. The process of smearing also frees the skin from all impurities, and is a means of continuing the vigour and strength of sheep unimpaired for some years longer than would otherwise take place. He apprehends that the free admission of rain, drifts, and cold, through an unsmeared fleece, generally reduces the animal to the lowest state of imbecility, and that this reduction of spirits and constitution shakes the health and makes the animal fail a year or two sooner than it otherwise would, if regularly and completely smeared.

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*Observations.*—The opinions of this anonymous correspondent appear to have been founded in experience; and may afford information to the highland shepherds, for whom indeed they are more particularly calculated, but cannot be considered as generally useful. The information they convey is not new, but has been admitted and acted upon in the elevated situations of Scotland for nearly a century. They have however the advantage of having been sanctioned by experience, and consequently stand in need of no additional recommendation.

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*Uses of Black Currants. Displayed by* DOMESTICUS.—*Farmer's Mag.* No. 28.

THE cultivation of the black currant is recommended by the writer to be pursued on an extensive scale, that the wine which they would afford, might be used as a substitute for foreign wine, the high price of which has removed that generous beverage far from the lips of people of moderate fortune. The wine made from the black currant is stated to be free from all the innoxious qualities of shrub, punch, whisky, &c. to be not only a healthy beverage, but to possess that *marked* and most admirable flavour, with a certain hardness, which is peculiar to the finest white wines of Spain and Madeira; and it is besides possessed of many medicinal qualities. The currants would ripen at a season when the husbandman would be at leisure to attend to the crop, for the hay would be finished, and the corn and potatoe harvest would not have commenced. The following receipt is added for making the wine, viz.—"To one Scotch pint of juice put two Scotch pints of water (cold). To every Scotch pint of this liquor add one pound and a half of moist sugar. Put it into a cask, reserving a little for filling up. Place the cask in a dry and warm room. The liquor will ferment of itself. Scum off the refuse: fill it up with the reserved liquor. When done working, add a Scotch

pint of brandy to 20 Scotch pints of wine. Bung it close till February or March following. Draw it off, putting the dregs through a jelly-bag till it be clear."

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*Observations.*—The enormous price of foreign wines must necessarily confine them to the tables of the rich as an article of luxury; but among the laborious classes the refreshment of sound malt liquor is justly allowed to be the common article of the country, and no substitute for that, or the wholesome unadulterated cider of some districts, is either to be expected or prudently sought for. But there are innumerable cases in which some refreshing vinous liquor, different from these, is frequently desirable for persons in delicate situations, and in an impaired state of health; family wines are an excellent substitute in these cases where foreign wines cannot be afforded: they are far preferable to spirits, which, however they may be diluted with water, are still deleterious. Family wines may be advantageously manufactured from many garden fruits. The red and white currant make excellent wine, but the acid quality of their juice prevents it from arriving at maturity, except after long keeping: the *black currant* is free from this objection; and from the blossom bud being enveloped in the leaf bud, the crop is more certain in unfavourable seasons.

The tenth volume of the Bath Society's Papers contains a valuable communication on the same subject, and points out many reasons why the black currant is preferable to most other fruits for domestic wines.

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*On the Labour of Oxen. By Mr.* John Billingsley.—*Bath Papers,* vol. x.

Esau Green, the servant of Mr. Billingsley, on a farm of 800 acres, the soil of a middling texture, ploughed, with a team of six oxen and a double furrow plough, between the 1st day of January and the 1st day of December 1804, or in eleven months, 385 statute acres of land; besides which 291 acres were harrowed in the same period. No other team was employed in the tillage of this farm, and the ploughman was paid for the same *by the acre:* the measurement was conformable to the survey, by which the lands of this farm were a short time before allotted. The oxen employed were home-bred, of the long-horned race, and were purchased in 1803 at £14 each: four of them were six years old, and four were four years old. Although eight oxen were kept, only six were worked at a time; the other two were changed as occasion required, or the ploughman thought fit; they were in no respect injured by their labour, but were in good

working order. The ploughman and driver were paid 1*s.* 4*d.* per acre for ploughing, and 6*d.* per acre harrowing; and in this was included all necessary attendance on the cattle at all times and seasons. The depth of ploughing was from 3 to 5 inches, and breadth of furrow 7 to 10 inches. The harrowing being all performed with six oxen, drawing very heavy long-tined harrows or drags, in many fields two bouts in a place; it is not unfair to estimate two harrowings as equal to the labour of a ploughing: $2\frac{1}{2}$ acres being usually ploughed in eight hours, and 5 acres on the average harrowed in the same time. The debit and creditor account is stated as follows:

Dr.

*Eight working Oxen from Jan. 1 to Dec. 1, 1804.*

| | £. | s. | d. |
|---|---|---|---|
| To hay consumed between January 1 and May 12, 19 tons, at 50*s.* | 47 | 10 | 0 |
| To 24 weeks keep at grass, May 12 to Oct. 1, at 3*s.* each ox | 28 | 16 | 0 |
| To hay Oct. 1 to Dec. 1, 6 tons, at 50*s.* | 15 | 0 | 0 |
| To repairs of yokes and bows | 0 | 18 | 0 |
| To wear of plough and dressing shares, mending chains, &c. | 4 | 13 | 6 |
| To cash paid Esau Green for ploughing 385 acres, at 16*d.* including driver and attendance | 25 | 13 | 4 |
| To cash paid ditto, for harrowing 291 acres, at 6*d.* ditto | 7 | 5 | 6 |
| | £129 | 16 | 4 |

Cr.

| | £. | s. | d. |
|---|---|---|---|
| By 385 acres ploughed, at 4*s.* $10\frac{1}{4}$*d.* per acre | 93 | 1 | 10 |
| By 291 acres harrowed, at 2*s.* 6*d.* ditto | 36 | 7 | 6 |
| | £129 | 16 | 4 |

Had the above work been let at the time, no person could have been found to undertake the ploughing under 8*s.* and the harrowing 4*s.* per acre. According to the proportion above stated, the work of these 8 oxen is equivalent to 578 acres ploughed in the year, caparisoned in the old-fashioned way with yokes and bows. The earnings of the ploughman were 13*s.* for himself, and 3*s.* for his boy per week throughout the year. Notwithstanding this favourable example, Mr. B. does not mean to contend, that oxen will answer in all counties, and on all soils: but

on level soils, unincumbered with stones, where good pasture may be found for summer and good hay for winter keeping, oxen with the double plough are justly entitled to a preference.

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*Observations.*—Mr. Billingsley has for 25 years past continued the uniform practice of letting his ploughing work by the acre, as in the instance before us: every operation on his well-managed farm or premises almost, is alike contracted for by tale, measure, or weight; his constant maxim being, "that the best method of making servants laborious and honest is, to make it their interest to be so;" a truth which we are sorry to see our agricultural brethren in general so little attentive to.

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*On the Slating of the Roofs of large Buildings. By Mr.* Lewin Tugwell.—*Bath Papers,* vol. x.

Mr. Tugwell intending, as far as we can gather from his very inflated and curious style of writing, to erect a very large building for different agricultural purposes, to be covered with thin Cornish or Welsh slates, contrived a method for preventing their being blown off or disturbed by the wind. The usual practice of boarding roofs, intended to be slated, is justly objected to by Mr. T. on account of the warping of such boards by the heat, and their retaining moisture between them and the slate: for slates of 18 inches long, the rafters are to be 20 inches apart: the laths are to be 2 inches wide and 1 thick, each one to be rebated on the upper side, half its width being taken off, to the depth of $\frac{1}{4}$ of an inch, or fully sufficient to bed the head of the slates; their middle (or rather 7 inches from the head), resting on the unrebated part of the next lath, to which it is nailed, and the lower end resting on the slate below: by this means, the slates being confined down near their middles each by two nails, while both their ends are at liberty to obey their shrinking or swelling, or that of the laths under them; the wind can have far less power to tear them from the laths, than in the common way, wherein the nails are very near to the head of the slate: where the outward air is wanted to be excluded, a slip of thin putty is directed to be laid along the unrebated part of the lath, and down the side joint of each slate: a new sort of brad-awl is recommended, for avoiding the splitting of the laths; while to prevent the jar usual in driving the nails, an iron is directed to be held underneath the lath, which will also clinch the nail, if of a proper length: the laths are directed to be spliced together at their ends, and each part carefully nailed to the rafter, by a carpenter, instead of leaving it to the slaters to fix on the laths, a

great portion of which they split for want of the proper tools for such business.

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*Observations.*—The method of slating here recommended and explained by drawings, appears very good; and though rather expensive, on account of rebating the lath, and the great overlap of the slates (one fourth or more of the roof having three thicknesses of slate, and the remainder two thicknesses), yet we doubt not of its proving very durable and effective, and where the slates are thin and good, more economic in the long run than the methods in use.

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*On the Culture of Wheat after Beans. By* J. C. Curwen, *Esq.* —*Trans. Soc. Arts,* vol. xxiii.

Mr. Curwen had forty acres drilled with beans, with intervals of 26 inches between the drills, before the end of February 1804. They were all tick beans, except those on one acre, which did not produce so abundantly as the rest. The ground had been sown with wheat in November 1802, but from the unfitness of the ground, which was a stiff clay lying so flat as to afford little fall for the water, great part perished; and above half the ground was resown with oats in April 1803; which were reaped in October, and the ground immediately ploughed up. It was very foul from grass and weeds, but the time did not admit of a second ploughing; and the beans, as above mentioned, were drilled on it in this state. The crop received no cleaning till the 10th of May; from which time till the middle of July the ploughs and harrows were constantly employed on it, and it was twice hand-weeded in the same time. The beans were cut on the 20th of August, spread thinly, and left exposed to the sun two days previous to binding. The field was cleared by the 29th, and immediately received two ploughings: was harrowed, raked, and hand-picked, to free it from weeds, and by the 29th of September the whole was completely drilled with wheat, rolled, and water-furrowed.

| | £. | s. | d. |
|---|---|---|---|
| The culture of the beans cost - - - - - - - - - | 134 | 12 | 2 |
| The expense of preparing the ground for the wheat, after the beans were cut, was - - - | 57 | 8 | 0 |
| | 192 | 0 | 2 |
| The bean crop of 628 bushels, at 5*s.* 4*d.* per bushel, was worth - - - - - - - - - - - - - | 167 | 9 | 4 |
| The expense of this method as a preparation for wheat | 24 | 10 | 10 |

Which deducted from 75*l.* 12*s.* the expense which a fallow would have cost, leaves 51*l.* 1*s.* 2*d.* in favour of this method; and as

several circumstances were unfavourable in this experiment, it is fair to conclude, that much more advantage would be derived from similar management where they did not occur.

The beans were not quite ripe when they were cut, which besides saving time, and improving their colour, without injuring their quality, has also the advantage of rendering the straw excellent fodder for horses: as Mr. Curwen states in a letter subsequent to that which contained the former part of this paper.

The gold medal was voted to Mr. Curwen for this experiment.

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*Observations.*—The culture of wheat and beans in successive crops in the hands of Mr. Curwen is not a new experiment. The Duke of Grafton had cultivated a field in Whittlewood Forest, of which he is the hereditary Ranger, with alternate crops of wheat and beans for more than twenty years without the intervention of a single fallow, and the result has invariably been crops superior to the moderate produce of other husbandry. Northamptonshire is so much farther south than Northumberland that the corn ripens much sooner, and more time is consequently allowed for the preparation of the ground; but there is no reason to conclude, that the same mode of husbandry would not be comparatively beneficial in the northern counties. The particulars of the Duke of Grafton's experiment may be found in the Annals of Agriculture.

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*Account of the Improvement of three hundred and eight Acres of waste Land. By Mr.* W. Taylor.—*Trans. Soc. Arts,* vol. xxiii.

Mr. Taylor, in May 1799, purchased 308 acres of heath-land, over-run with whin, fern, and heath-grasses, much of it consisting of bog and spungy land, with many springs interspersed.

He commenced with "draining, paring, burning, and making new hedges." The drains amounted altogether, when measured, to upwards of eighteen miles in length: some of them were made with flag bottoms, and side walls 20 inches high. In the running sands where stones would sink, drains were made with a kind of wicker work, composed of timber ends, sawed off from the props used in collieries, and strong whin shanks, and covered with straw, over which sods were laid: these formed floating drains, which the author found to be very durable.

The mode of cultivation subsequently adopted, was, "first to fallow, clean the land well, and lay on from 24 to 32 *bolls* of *clod* lime per acre, with a fair proportion of manure, and sow with turnips in the early part of June, to be eaten off by sheep in the winter months. In the following spring to sow the land with six pounds of white clover, four pounds of red clover, and half a bushel of rye grass per acre, with whatever grain the land was

best adapted for. The first year this was to be mown, the second year kept in pasture, and the third year the land was to be sowed with oats, and the following year fallowed, and so on in rotation, till the heath-roots were sufficiently destroyed."

| | £. | s. | d. |
|---|---|---|---|
| The purchase of the land cost - - - - - - - | 2665 | 0 | 0 |
| Draining, hedging, nurseries, cattle, taxes, interest of money, and other expenses, stated | 4424 | 18 | 4 |
| | 7089 | 18 | 4 |
| Value of stock at Martinmas 1803, deducted - - | 2058 | 10 | 5 |
| Expended on the estate - - - - - - - - - | 5031 | 7 | 11 |
| The estate valued by Mr. Fryer was worth in March 1804 - - - - - - - - - - - - - | 9023 | 13 | 0 |

From which the above sum being deducted, left 3992*l.* 5*s.* 1*d.* gain.

Mr. Taylor mentions his having derived great benefit from feeding his horses with oat-sheaves chopped in the straw-chopper; which saved the expense of thrashing, obliged the horses to chew the oats properly, and made hay unnecessary for them, which last as he was situated was a very material object.

He recommends sending chopped oat-sheaves in bags, with drivers, instead of hay, which they are habituated to waste extremely.

Mr. Taylor received the gold medal from the Society for Arts for this communication.

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*Observations.*—The method pursued by Mr. Taylor for reclaiming the waste land which he had purchased, was very judicious, and the benefit he derived amply repaid the exercise of his discretion. The mode of giving oats to horses in the straw unthrashed, may be adopted with profit in all the northern counties, where hay is exceedingly scarce and valuable, and well deserves the attention of the agriculturists of that part of Great Britain.

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*Account of Captain* Miller's *Sheep-shears.—Trans. Soc. Arts,* vol. xxiii.

The object of Mr. Miller's shears is to prevent cutting the skin of the sheep in shearing, which frequently occurs with those of the common kind: this is effected by screwing a thin plate of iron to the back of one of the blades, shaped in the same form, but without edges, and placed so that its side lies exactly under the edge of the blade: this part being kept next the skin of the

sheep in shearing, prevents its ever rising high enough to meet the juncture of the blades.

The plate must be taken off whenever the shears require to be ground; and its front must be ground proportionally with the blade, that it may fit properly as above mentioned. These shears were found to perform extremely well on trial, and the invention was rewarded with the silver medal by the Society of Arts.

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*Observations.*—If the plate had oblong perforations cut through it, about half an inch in length, at the place where each screw passed it at right angles to the edge, it might be made for a long time to fit the blade without requiring to be ground; by which much trouble might be saved. The object aimed at by the inventor, however, will be completely obtained by the adoption of the plate in its present form. The young and inexperienced shearer will acquire a competent knowledge of the art much sooner by the use of Captain Miller's shears than by learning with those which are commonly used.

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*New Method of propagating White-thorn. By* SAMUEL TAYLOR, *Esq.—Trans. Soc. Arts,* vol. xxiii.

MR. Taylor has presented an account to the Society for Arts, &c. of very successful experiments, made by him on the propagation of white-thorn from cuttings of *the root*; which he found to have the following remarkable advantages over the common method: 1st, Full three years are gained in the advanced growth of plants raised from the root. Mr. Taylor found those of two years old equal in every respect to the average of plants six years old raised from haws; reckoning from the time of sowing the haws. 2d, They cost much less. Hawthorn plants are very dear in general. Those raised from the root cost little more than the labour of cutting the roots. 3d, They may be had at all times in any quantity. Those raised from haws are often extremely scarce, and in some places not to be had at all. 4th, They are much more hardy, and less liable to fail: Mr. Taylor did not lose five plants in a hundred of those from the roots; but of those from the haw a very large proportion always perish. 5th, Thorns of vigorous growth, and of large spines, may be raised in preference by this method, as the plant is always of the same nature as the parent stock; which seldom happens in plants raised from haws. Mr. Taylor recommends the roots of the hawthorn to be cut into lengths of about four inches, and the thickness they usually obtain in between two and three years growth. On the end next the stem they are to be marked by two cuts, while the other end receives but one cut. They are to be planted in April, in rows half a yard asunder, and four inches from each other in

the row, with their upper ends one fourth of an inch out of the ground, and well fastened: from these rows they are to be moved to form hedges when of sufficient growth. A large quantity of roots may be procured, by planting a hedge in any convenient place; trenching the ground two yards wide and two grafts deep at each side, repeating the trenching every two or three years, and taking up the roots which have shot forth in that time, which will all be of the proper age and thickness for planting. The Society for Arts, &c. voted Mr. Taylor the silver medal for this discovery.

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*Observations.*—The great importance of good hedges in securing crops, sheltering cattle, and in their less generally known but no less certain effect in improving the temperature of the air, renders this discovery of Mr. Taylor's of great importance.

It is extremely probable, that fruit-trees might be raised in this method with equal success from the roots of *original stems*, and perhaps escape many of the disorders to which those raised from grafts are liable.

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*Comparative Experiments on the drill and broad-cast Culture of Turnips. By Mr.* William Watson.—*Trans. Soc. Arts,* vol. xxiii.

The premium of ten guineas was voted by the Society to this gentleman for his experiments, which form the subject of the communication under notice. His first experiment was made in a field of ten acres of a light gravelly soil: four acres were sown broad-cast, and six drilled at 26 inch intervals. The produce of the drilled part in weight was to that of the broad-cast, in some places as five to three, and in others as six to five; this difference of result, Mr. Watson attributed partly to a few days interval in the times of sowing, and partly to a small difference in the quality of the dung used as manure.

The second experiment was conducted with the most minute attention to the equality of every matter relating to each object of the comparison, and with an accuracy worthy of imitation. In the beginning of June 1804, 3023 square yards of land were chosen of the same quality and condition, all of an inferior quality, and part of the above ten acres. This ground was divided into three equal ridges, each of which received 27 two-horse cart-loads of prepared dung, to the equality of whose nature the most minute attention had been paid.

One ridge was sown in drills on one-bout ridges twenty-six inches asunder: another was sown broad-cast; and the third in drills upon a flat surface with intervals of thirteen inches. They were all sown on the same day, with the same sort of seed, without

the smallest variation in the weather occurring, either then, or when they were hoed, which was all performed by the same hand, who set all the turnips out about one foot asunder.

The produce of half of each ridge was weighed on the 29th of January 1805, after cutting off the tops and tap roots. The ridge drilled with broad intervals produced at the rate of 16 tons, 10 cwt. 4 st. 6 lb. per acre; that with narrow drills 11 tons, 19 cwt. 3 st. 11 lb. ditto; and the broad-cast ridge 12 tons, 8 cwt. 1 st. 13 lb.

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*Observations.*—The result of these experiments does not seem adequate, in point of importance, to be rewarded by a public society. Of the two drilled crops in the last experiment, one was superior and the other inferior to the broad-cast, so that no preference is decided to be due to either method of sowing. In short, these trials merely shew, that the greatest crop of turnips in weight may be obtained by keeping them at considerable distances from each other, and the united experience of all practical agriculturists has long decided, that a complete hoeing is the most effectual recipe for a good crop.

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*On the Culture of Carrots. By Mr.* W. Wallis Mason.—*Trans. Soc. Arts,* vol. xxiii.

Mr. Mason mentions first, that the culture of carrots has been used in Suffolk for ages, and has much increased of late. Carrots may be reared on inferior arable land, and will supply the place of the hay and grass consumed by cattle in the winter months, which is the produce of the best land (the meadow and upland pasture).

A red loamy sand is preferred for the culture of carrots, but any soil not too tenacious and of sufficient depth will produce them in sufficient abundance.

Mr. Mason directs the soil to be ploughed *fourteen* inches deep, by first ploughing a furrow seven inches deep in the usual manner, and the following with a second plough in the same furrow, which by the assistance of an additional horse brings up the soil from the depth required, and completely mixes the lower with the upper earth.

The lands or stitches should be from 18 to 25 yards wide; the ground should be perfectly clean. The carrots succeed well after barley, clover, or artificial grasses.

The seed should be sown directly after ploughing, to give it every advantage over the weeds in growth.

Mr. Mason recommends six pounds of seed to the acre, to be steeped twenty-four hours, rubbed well against the side of the tub to break the projecting fibres, and mixed with two fourths marl

and one fourth saw-dust previous to sowing; which is best done in drills from six to nine inches asunder, from the middle of March to the 12th of April. The land should always be harrowed after sowing.

The proper time to commence weeding or hoeing is when the plants acquire the parsley-leaf, or when they are about half an inch out of the ground; frequently six weeks elapse after sowing before they arrive at this state. In hoeing, every part of the soil should be stirred that is possible; at the second hoeing, the plants may be set out at the proper distance from each other. When much weeds have sprung up, hand-weeding at the first is preferable to hoeing; but if the crop is perfectly clean, hoeing will answer every purpose; but this rarely occurs.

The weeders should never be suffered to pull up any carrot plants; these are always best set asunder by the hoe. In the first hoeing, care should be taken not to bury the plants, and to leave them sufficiently thick; one weeding and two hoeings are generally sufficient; by the time they are performed the plants are mostly high enough to shade the land: the hoe used should be four inches broad and 1½ inches deep, with a neck of about two inches long connecting it with the handle.

Carrots should not be taken up until full grown, but always before the fibrous roots begin to shoot in the spring.

By the above management eighteen loads of carrots, of forty heaped bushels to the load, will generally be produced by each acre. The same ground will do for successive crops of carrots; but in this case manure is necessary.

They are taken up with a narrow spade, which the labourer strikes with one hand into the ground, pressing it sideways at the same time, while he draws the root with the other hand.

To shew the advantage of deep ploughing, Mr. Mason has given figures of carrots produced on single and on double furrows, which prove, that on the latter they attain nearly a double size.

After this follow some directions for raising carrot-seed; and then is inserted the manner of giving the root to cattle, and of washing and storing it.

Mr. Mason states, that carrots pay one third more when given to working horses than to other cattle. One heaped bushel was allowed by him to each cart-horse every day with as much cut provender as he could eat, composed of two thirds wheat or oat straw, and one third clover; barley straw is apt to gripe: horses should always be baited with dry food, or drink their water before carrots are given. By this method of feeding, two thirds of the hay, and all the corn usually consumed, are dispensed with, and horses will be in better condition fed thus than on full allowance of hay and half a peck of oats each day.

Carrots should not be given to horses while they are heated by work; and are improper for riding-horses, as nimble exercise makes them laxative.

Mr. Mason then gives directions for curing cattle that happened to be griped by carrots; after which he states, that feeding cattle improve more on carrots than on potatoes and turnips; that they are excellent food for sheep at lambing time, but should be cut small for them. That store-pigs may be fattened by carrots alone, and large hogs on them and half corn feed. That cows with the first calf thrive better on a bushel of them and straw per day than hay alone. That a peck each day to weaned calves agrees well with them; and that cows give more milk on them and straw than on hay alone.

Mr. Mason thinks carrots much more profitable than turnips; that a bushel of them are equal to 18 lb. of hay as food for horses; at which rate the produce of half an acre of them will be of as much value as that of an acre of hay.

Mr. Mason takes some notice also of the mode of paying labourers; and speaks much in favour of allowing, in dear seasons, every single man a stone of flower per week, and every married man $1\frac{1}{2}$ stone, and an $\frac{1}{2}$ stone for every child; the master paying the additional price above two shillings per stone.

Mr. Mason received the silver medal from the Society of Arts for this communication.

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*Observations.*—Mr. Mason's directions for ploughing to the depth of 14 inches for carrots shew, that they can only be produced to advantage in peculiar soils: in many situations where good crops of other vegetables may be raised, to plough 14 inches deep would be impossible; and in many others, where it might be possible, the lower soil is of such a barren nature, that if turned up among the upper soil it would render it unproductive for several years: many instances of this kind have been seen in Devonshire for example; and in some places the productive soil is so shallow as not to exceed six inches.

This deserves particularly to be noticed, as Mr. Mason has made a comparison with crops which can be reared where carrots cannot, which is an inaccurate mode of comparison; and his praise of them should therefore be limited to their productiveness on the deep soil mentioned.

A very interesting paper on the culture of carrots has been published in the last number of the Repertory of Arts, &c. which we shall notice in course in our next.

*On forming and repairing Roads.—Farmer's Mag.* No. 28.

The author of this paper mentions, that the roads near Edinburgh were formerly made by laying large stones close together seven or eight inches thick at the bottom, and laying over these a coating four or five inches of hard stones broken small (which throughout this paper is called *metal*); the contractors for these roads only taking care to keep the surface smooth, by levelling protuberances and filling up ruts. Without renewing the upper stratum of broken stone, it gradually was worn away, till the large stones appeared and the roads became so rough as to be almost impassable. Those who next took the management of the roads, not sufficiently considering the subject, supposed the defect lay in placing the large stones at the bottom, had them broken small as the rest, and formed roads of this material only to the depth of fifteen inches, which the pressure of heavy carriages soon cut into worse ruts than when the bottom was laid with large stones.

The following directions are given for making new roads by the author, who calls himself an *old road-maker*; "Form the ground quite flat from side to side, then cut a bed capable of containing half the quantity of *metal* to be applied; and when the materials are put on, *box up* the sides and sink the gutterways, by which means the road will be sufficiently rounded. If it is to be wider than the ordinary breadth, it will be better not to sink any of the materials into a bed, but to spread the whole on the surface. Any kind of *metal* will answer for laying the bottom part; if the upper part, which should consist of the hardest materials, well broken, is always kept to its proper depth by fresh supplies, the under part can never be injured."

The author also remarks, that a road should never decline at the sides more than one inch in thirty; for on such a road the carriages will hang so much on one side that the roads will be cut, both by the greater weight being thrown on fewer wheels, and from the twist which the wheel makes, from the oblique position in which it moves.

A road laid with large stones, coated with well-broken *metal* at top, must necessarily cost less than when it consists wholly of stones broken small, and will be more easily kept in repair, as the ruts will not go so deep as in the latter case. All that is necessary to keep such a road in repair is, when small ruts are seen, and the upper coat appears to fail, to supply the defective part with well-broken *metal* to the depth of two or three inches, a cart-load of which will cover seven or eight square yards. The *metal* should be applied before the dry season sets in, and kept close together till it consolidates. It should be also cleared of mud and loose stones

twice or thrice a year; which may be done at a small expense, as in most cases a girl can rake in the loose stones of half a mile, and a man collect the mud of one third part of a mile each day.

It is also recommended to make roads by contract, and in doing so to prefer small jobbers to great contractors.

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*Observations.*—Although we are desirous in this work to avoid as much as possible verbal criticisms, yet we think that the introduction of technical words in a sense not generally understood, tending to create confusion, should always be reprehended; and among these we must class the favourite word *metal* of the author, used very unnecessarily by him for stone, and more improperly, as roads are now really made of metal in many places. His directions are generally good, but are rather obscure in the passage we have quoted.

The principal point which he advises, that of laying a foundation of large stones, is very commendable. This was the practice of the Romans in their famous *viæ*, but to a much greater extent than is thought of by the Edinburgh road-maker. The Appian way is described to have been made, "all of huge stones, generally a foot and half large on all sides:" many miles together of it still appear to be as entire as when first made, and it has lasted now nearly 1900 years.

Such a foundation as this, though no broader than the Appian way, which is only twelve feet across, would perhaps be too expensive; but one formed of a common pavement would not, at least for the part of the road on which heavy carriages were to pass. A foundation of this sort, kept well covered with a stratum of stones broken small, four or five inches thick, would form a road whose durability would probably render it less expensive in process of time than the common sort, the first cost of which is less.

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*Account of a Paper on Experiments on the Growth of Timber Trees. By Mr. J. Farey.—Trans. Soc. Arts,* vol. xxiii.

The substance of this paper contains rather the *basis* of experiments on the growth of timber-trees than experiments properly so called. It chiefly consists of accounts of the measurement of a number of trees made in July 1794 in a small wood of eleven acres in Waveudon parish, Bucks, delivered with such a minute attention to circumstance, that the moral qualities of the labourer employed, the sort of paper used in the account-book, viz. foolscap, and a very particular description of the measuring tape used on the occasion ("made by Mr. Cary, optician, in the Strand, for measuring timber"), are most methodically and perspicuously related.

The measurements of the trees are contained in tables, in which

they are divided into classes according to their different sizes. The first tables contain the particulars of the height, girth, solid contents, and mean contents, according to their classes, of 108 trees, as a specimen of the manner in which the whole wood was measured. Three of the other tables contain accounts of the number of spruce firs, Weymouth pines, larch, beech and birch trees of each class, contained in the three divisions of the wood referred to in a small map of it, which accompanies the paper; and the remaining table contains a summary of the whole number of trees of the 27 different classes, amounting to 18,727; of which 14,590 were measured, and the rest estimated.

From all this pomp of circumstance at the commencement we expected that some adequate result should follow, but were greatly disappointed to find only the account of the measurement of 130 of the above 18,727 trees, taken in the year 1804, and divided into 24 classes, commencing from the tenth class, each class consisting of trees of the average girth, at four feet from the ground, denoted by its respective number in inches: but no inferences are drawn from this small comparative measurement. Mr. Farey, indeed, makes a calculation, from which he infers, that previous to 1794 the wood paid the proprietor by its increasing value at the rate of *1l. 7s. 5d.* per acre; but nothing is said of what is paid from that period to 1804, which was the interval between Mr. Farey's first and second measurement, and to which his observations might be expected particularly to refer.

Mr. Farey has, indeed, apologized for not giving the value of the trees at the last measurement, and for some other deficiencies in the paper; but we think he would have done better to have withheld it altogether than have held it up to public notice in such an unfinished state, that to make it of any utility, the public must be indebted to the future labour of some other person.

The silver medal was voted to Mr. Farey for this paper by the Society for Arts, &c.

The vigour and bustle of the commencement of this business, compared with its termination, could not but remind us of the old fable,

*Parturiunt montes, nascitur ridiculus mus.*

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*On the Advantages of the Use of Oxen and neat Cattle in Husbandry. By Lord* SOMERVILLE.—*Bath Papers*, vol. x.

A DETAILED account is first given by his Lordship of the agricultural labour which his twelve oxen performed in the year 1803, being equivalent to the ploughing of 1000 acres! The average amount of labour is two acres of lay ground per day, and of fallowing and stirring more than two acres; but of the second cross-ploughing, or earth, somewhat less. His Lordship's team

consisted of four oxen, a man, and a boy, to each double-furrow plough, and to each four-wheeled waggon: the ploughing in general very deep; the fields small, not exceeding 4½ acres each on the average; which circumstances are to be considered as adding materially to the labour. The working stock on his Lordship's farm consisted of sixteen steers and oxen, two bulls, and three light horses: viz. six five-year-old oxen, six four-year-old steers, and four three-year-old ditto: they were fresh, growing stock, and were regularly turned out to graze, after the barley-sowing, at six years old: the object aimed at was, to carry on a course of crops on the most speedy and vigorous system, but without injury to the growth of the stock. The labour, severe as it was, did not injure the health or growth of the stock in the least; as the annual exhibition of them (in Barbican, London) after *only ten months grazing*, has sufficiently exemplified. Fifty-seven acres of wheat were, in the autumn of 1804, ploughed, sown, and manured, in a complete manner, according to the usage of the country, within three weeks, although the weather was unfavourable, and the land worked close and heavy: the last nine acres were ploughed, sown, dragged, and harrowed, in one day! In twenty years labour, his Lordship has not lost one ox or steer, or ever broke a yoke or pair, by sickness, death, or accident: so far, therefore, from incurring a loss of 25 per cent. or more, of the value, as is the case of horses, worked after their full growth, his Lordship and others calculate on an actual gain of 20 per cent. yearly by the working of steers and oxen, from three to six years of age.

*Observations.*—This truly spirited and noble improver, in transmitting the above particulars to the Bath Society, waved completely any claim to the premium offered by that enlightened body, for the greatest exertion and success in ox-labour, and in the most handsome terms he recommends Mr. Billingsley's exertions, noticed in the present number, p. 550, to the attention of the Society.

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*Method of improving boggy Land by Irrigation; with general Remarks on watered Meadows. By Mr.* W. Smith.—*Trans. Soc. Arts*, vol. xxiii.

By Mr. Smith's method of irrigating boggy land, it was rendered firm, the rushes and noxious plants destroyed, and grasses of a good quality produced; and even ferruginous waters had in it a good effect.

It was thus performed: "The whole surface of the boggy ground was pared with a breast-plough, and the *peaty* matter thrown together in ridges like common high-ploughed land, with a ridge, like a head-ridge, at one end of each set of ridges. Each

ridge had a cut, or channel, for the water on its top, and a drain in the furrow, or hollow, between it and the next ridge. The head ridge had a large channel for water on its top, which supplied all the other ridges with water; and this main ridge was itself supplied by its connexion with a large channel or feeder, which first conveyed the water out of the common brook into the meadow."

"The furrow between each head ridge, and the ends of the (upper) beds, had a large drain into which all the channels of the drains in the (upper) furrows discharged their water, which was by this main drain carried back to the brook again (at a lower level)." To raise the water high enough to run into the upper water-course, a dam was placed in the brook, to pen up the water till it rose near the surface.

Mr. Smith observes, that where the quantity of water is not sufficient to float the whole meadow at once, it may be divided into as many parts as are judged expedient, of different elevations, on each of which the above method is to be pursued; and hatches, or sluices, are to be fixed in the main water-course, at the head of each part, to turn the water off or on each in succession as desired. A watered meadow of nine acres in Bedfordshire, mentioned by Mr. Smith, had three such divisions; each of which was also occasionally divided into smaller parts, by putting hatches, made of a board cut to the shape of the main feeders, into such of them as were to be closed.

To put the above method in execution, it will be necessary to new-model the surface, which can only be done to any advantage where the ground has been previously levelled by nature; for where inequalities of the surface are great and numerous, the expense of bringing it into a regular form would be too great. In such cases, the water-courses, instead of being straight, must wind along the natural elevations of the ground, and corresponding drains at due distances must accompany them; and, in general, the water must flow over one side of the water-course on the land, instead of over both as in the former method.

The great object in irrigation, is to bring a sheet of *running water* over the land; for this purpose the water must always be kept overflowing at the edges of the water-courses, and running off in the drains; and as it should never be so deep as to cover the tops of the grass after being cut, when the grass grows the water will no longer be seen; but in walking over the ground its motion will soon be perceptible to the foot.

The supply of water must regulate the quantity of land to be floated: hence, when this supply is scanty, to make the most of it, it must be distributed over various divisions in succession, each of which should have its full allowance of water running over it for a proper length of time; and in the successive application of the water to the different parts, care must be taken to

put it first over those pieces of meadow which are disposed to produce the earliest vegetation, and on the rest in the order of their priority in this respect; by which management the crops will be much greater than if the water were spread at once over too much ground.

In most meadows, when the ground is well saturated with water, and the grass has thickened, vegetation will not be retarded by stopping the supply, and turning it elsewhere; and meadows which have received most water in autumn, will want least in spring.

The spring floating may be continued at intervals, if the water be not foul, till the grass has gained a considerable height; but it must only be put on for a day or two at a time, to cool the ground and keep the grass growing.

When the hay is removed, even from one third of the meadows, no time should be lost in putting the water on that part of it till it is pretty well soaked, and then on the rest as they are cleared.

Cattle prefer the highest and thickest grass on water-meadows, contrary to what they do on common pastures. Where it is high it will grow quickest, and thicken most at the bottom, the roots will get more hold in the ground, and it will consequently not be so soon subject to feel the want of water during the time of feeding, and will make a much stronger shoot as soon as the water is again let on it.

As much of the success of water-meadows depends on the person who superintends them, Mr. Smith recommends that this office should be intrusted to one person only at the same time, and not to change the trust too often; and that where premiums are given by agricultural societies to the proprietors for the greatest produce from water-meadows (which he much advises), a smaller premium should be also given to the manager.

An account (given to Mr. Smith by order of the late Duke of Bedford) is annexed of the produce of the before-mentioned meadow of nine acres in Bedfordshire, made from a bog and irrigated as described, by which it appears, that from March 29th, 1803, to June 21st, 1804, this meadow produced above seven tons of hay, fed twelve score sheep for three weeks, four score fat sheep for three weeks more, and eight score and four lambhogs for nine weeks, though it was not managed in the best method it might have been.

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*Observations.*—The practice of artificial irrigation, though of modern introduction in this country, is of high antiquity on the continent, particularly in the hot climates of Asia; and now that it so deservedly excites public attention, to collect and publish exact accounts of the method in which it is managed in those

places, might throw considerable light on the subject, and be of great benefit to agriculture.

In addition to what Mr. Smith mentions, "of the propriety of attending to the order of priority in which meadows produce their grass naturally, to direct the succession in which they are to be watered," it should be noticed, that as different *species* of grasses ripen at various times, by sowing each species separate, the order of produce might, in a great measure, be directed for each portion of ground, as best suited the levels for successive watering.

Where water is very scarce, and the method described by Mr. Smith of course cannot be followed, it might be worth while to try the effect of floating successive levels for a day (or some short period) at a time, with stagnant water an inch or two above the surface of the ground, but so as not to cover the tops of the grass, and to let it run completely off afterwards, by a system of drains and water-courses similar to that described. There is the more reason to imagine that benefit might be derived from this method, as in Egypt, and other places situated like it, where the water stagnates on the ground for even some weeks at a time, the greatest and most lasting benefit is notwithstanding derived from it.

By this way it is obvious, in many situations, the *same water* might be made to irrigate many portions of land in succession.

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*Account of the Extirpator.—Agric. Mag.* No. 3, *New Series.*

The extirpator, or scalp-plough, as it is denominated by the inventor Mr. Hayward, of Stoke Ash in Suffolk, is known in particular districts of England by the name of a scuffler, tormentor, or nidget, and has been since denominated a cultivator, arator, &c. This instrument is designed to break clods, fine the land, and draw up weeds; but its most important use is to prepare the land for spring sowing without the help of a plough; by which not only much expense is saved, but the seed is got in more expeditiously in a critical time, and with the land in a far better state than could be obtained by the common method of ploughing. This plan of husbandry is said to have been for several years past getting into practice, and to be particularly advantageous upon strong lands, which have been well fallowed and laid up in autumn; and it is asserted, that lands of a light texture might be sufficiently cultivated for years together by this implement, without any assistance from the plough. The extirpator will work on all lands, and may be used by any person who can manage a plough, and will work over an acre in an hour without distressing the horses. It consists of a number of shares, eight inches broad and nine inches long, fixed to stalks rising ten

inches, which are inserted in parallel beams eleven inches from each other, and the same distance between the stalks in an alternate position. The instrument has handles the same as a plough, and is fixed to the wheels of a common wheel-plough, and made to go deep or shallow in the same manner.

In No. 261 of Mr. Young's Annals of Agriculture, another account is given by T. Estcourt, Esq. of this implement, under the name of the Scuffler, in which Mr. Estcourt relates an anecdote of one of his tenants having been so delighted with the usefulness of a scuffler, which he had ordered in consequence of seeing Mr. Estcourt's, that in the excess of his joy he ran with five guineas to the maker of the machine as an acknowledgment of his gratitude; the money was however properly declined. The merits of the instrument which had caused this ecstacy are described by the learned gentleman who made the communication, to arise, independent of the great reduction of the expense of tillage, from rendering a plough unnecessary, and from making land much finer than any plough can do, even with the assistance of drags and harrows. Mr. Estcourt states his firm belief of this being the fact, but admits he has not studied it sufficiently to be certain why it should have that effect.

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*Observation.*—The favourable opinion given of the scuffler is consistent with the opinion of many other intelligent farmers who have adopted it.

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## TO OUR READERS.

*The present Number concludes the second volume of this work. We have been under the necessity of extending its bulk considerably beyond our usual limits, in order that the volume might contain accounts of every matter (agreeably to our plan) which has been made public during the year. Nevertheless, we have found it necessary to defer noticing till our next Number the Second Part of the Transactions of the Royal Society for* 1806, *and the First Part of the fifth volume of the Communications to the Board of Agriculture, published too late for our purpose. The Table of Contents, with the Indexes to this and the first volume, will accompany the eighth Number. The advance in price of the present Number is proportionate to the increased size.*

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